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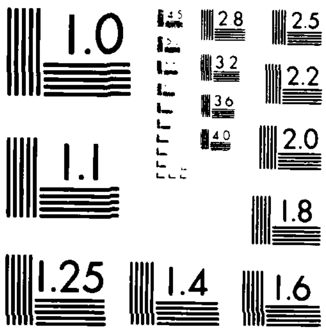

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M-X/MPS

ENVIRONMENTAL

TECHNICAL REPORT

AD-A149 906

PRELIMINARY FEIS

REVIEW COPY 2 OCTOBER 1981

ETR 16
AQUATIC HABITATS
AND BIOTA

DEPLOYMENT AREA SELECTION
AND LAND WITHDRAWAL/
ACQUISITION

DEPARTMENT OF THE AIR FORCE

M-X ETR-16

ENVIRONMENTAL CHARACTERISTICS OF ALTERNATIVE DESIGNATED DEPLOYMENT AREAS: AQUATIC HABITATS AND BIOTA

Prepared for

United States Air Force
Ballistic Missile Office
Norton Air Force Base, California

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By

Henningson, Durham & Richardson, Inc.
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2 October 1981

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DEPARTMENT OF THE AIR FORCE
WASHINGTON 20330

OFFICE OF THE ASSISTANT SECRETARY

Federal, State and Local Agencies

On October 2, 1981, the President announced his decision to complete production of the M-X missile, but cancelled the M-X Multiple Protective Shelter (MPS) basing system. The Air Force was, at the time of these decisions, working to prepare a Final Environmental Impact Statement (FEIS) for the MPS site selection process. These efforts have been terminated and the Air Force no longer intends to file a FEIS for the MPS system. However, the attached preliminary FEIS captures the environmental data and analysis in the document that was nearing completion when the President decided to deploy the system in a different manner.

The preliminary FEIS and associated technical reports represent an intensive effort at resource planning and development that may be of significant value to state and local agencies involved in future planning efforts in the study area. Therefore, in response to requests for environmental technical data from the Congress, federal agencies and the states involved, we have published limited copies of the document for their use. Other interested parties may obtain copies by contacting:

National Technical Information Service
United States Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22161
Telephone: (703) 487-4650

Sincerely,

JAMES F. BOATRIGHT
Deputy Assistant Secretary
of the Air Force (Installations)

1 Attachment
Preliminary FEIS

TABLE OF CONTENTS

Page

LIST OF FIGURES

iv blank

LIST OF TABLES

1.0 INTRODUCTION

Aquatic species and habitats are important for several reasons: (1) many native aquatic species are protected as threatened or endangered, (2) game fish supply recreational fishing, (3) these habitats are water sources for terrestrial wildlife, and (4) they are stopover points for migratory waterfowl. The Nevada/Utah study area is characterized by a high degree of endemism in its native biota (i.e., many species or subspecies are confined to a small geographic area, for example, a portion of a valley or even a single spring). Many of these species are protected by federal or state laws and require impact assessments and mitigation appropriate to Section 7 of the Endangered Species Act or similar legislation. In addition, a number of native species not currently protected by law have been recommended for such protection by local experts. The Texas/New Mexico study area has a less diverse native aquatic fauna, which includes few endemic species.

Both native and introduced species provide fishing opportunities. Fishing is a major recreational activity for a wide cross section of resident and nonresident sportsmen.

Aquatic habitats provide water and forage for terrestrial wildlife, particularly birds and the larger mammals, and for this reason they are some of the most important habitats in the area, without which colonization of the surrounding vicinity could not take place. Many surface water habitats in the project area provide stopover points for migratory waterfowl and their absence would alter seasonal flight patterns and cause crowding and possible mortality at remaining wetlands and water holes.

Springs, streams, and impoundments also provide swimming, camping, and picnicking areas. Bird and wildlife observation in the study area is usually best near aquatic habitats. Since surface waters are already scarce throughout the study area, their utilization not ony by fish and wildlife, but also by sportsmen and other visitors indicates their importance as a resource.

2.0 AQUATIC HABITATS AND BIOTA

2.1 NEVADA/UTAH

AQUATIC HABITATS (2.1.1)

Most of the Nevada/Utah study area is within the Great Basin, except for the pluvial White River system which is a part of the Colorado River drainage. The Great Basin is characterized by internal drainage with few rivers, the largest being the Humboldt, which is north of the study area. The large natural lakes (Tahoe, Pyramid, Walker, Great Salt, and Utah lakes) of the Great Basin are all outside the study area. Perennial cold water streams occur in most of the mountain ranges, and isolated springs which remained after desiccation of Pleistocene lakes in the Great and Bonneville Basins are found in lowland areas. The pluvial White River system, located in the south-central portion of the study area is biologically similar to the Great Basin. Aquatic habitats are limited to springs and a few perennial streams, primarily in the mountains. Most if not all of the natural waters in the study area have been altered by human activities related to agriculture, grazing, and urbanization. In addition, impoundments of various sizes have been constructed throughout the area.

A variety of native aquatic organisms at all trophic levels inhabit these springs, lakes, and streams, and many endemic forms have evolved as a result of isolation. In addition, numerous exotic species have been introduced by man. These introductions, along with habitat modifications, have often been detrimental to the native species. For example, the endemic Lahontan and Bonneville cutthroat trout have maintained pure strains in only a few isolated mountain streams. Stocking of rainbow trout in their habitats has often resulted in hybridization. Overfishing and habitat degradation have also reduced native trout population.

The three major types of permanent aquatic habitats considered here are point (springs and seeps), linear (creeks and rivers), and large area (ponds, reservoirs, and lakes) habitats. Although a significant number of large area habitats are scattered throughout the siting area, this type is generally not as important a contributor of aquatic habitat as the other two types in the siting area. In addition, various ephemeral wetlands and floodplains support aquatic resources during portions of wet years.

Wetlands (2.1.1.1)

The term "wetlands" means those areas that are inundated by surface or groundwater with a frequency sufficient to support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include swamps, marshes, bogs, and similar areas such as sloughs, potholes, wet meadows, river overflows, mud flats, and natural ponds.

Wetlands have particular importance because they are protected by Executive Orders 11988 and 11990, which were issued by President Carter as part of a comprehensive environmental message of 24 May 1977. The orders link the need to

protect lives and property with the need to restore and preserve natural and beneficial wetland values.

The purpose of Executive Order 11990 is "to avoid to the extent possible the long- and short-term adverse impacts associated with the destruction, modification or occupancy of wetlands and to avoid direct support of new construction in wetlands wherever there is a practicable alternative" (Executive Order 11990).

In addition to protection by executive orders, wetlands of the Nevada/Utah area are often recognized, managed, and/or protected as part of other programs such as National Wildlife Refuges and Ranges, Unique and Nationally Significant Wildlife Ecosystems (U.S. Fish and Wildlife Service), Research Natural Areas (Federal Committee on RNA), National Parks, Monuments, and Recreation Areas (National Park Service), State Wildlife Management Areas (Nevada Department of Wildlife and Utah Division of Wildlife Resources), and State Parks, Recreation Areas and Reserves (Nevada and Utah State Parks Divisions).

The National Wetland Inventory of the U.S. Fish and Wildlife Service reports that wetlands mapping in Nevada and Utah has not been started, so there is no official delineation of wetlands for the project. Figure 2.1-1, however, shows major wetlands and aquatic habitats in the M-X study area. All perennial streams, major rivers and some washes are mapped in this figure. It is unlikely that much of the M-X system would be sited in wetlands since these are generally geotechnically unsuitable for construction.

Few permanent rivers fed by runoff are present and most of the wetlands in the Nevada/Utah study area are formed by springs. The Humboldt River and its tributary, the Reese River are exceptional. Several types of wetlands are formed at these springs or along permanent or intermittent rivers and streams depending upon site-specific physical characteristics. Wetlands may also be associated with lakes, but even though many valleys in the study area are closed basins with internal drainage, few contain permanent lakes. An exception is in Ruby Valley, where Ruby Lake is supported by drainage from the east side of the Ruby Mountains (Cronquist et al., 1972, p. 92).

The Corps of Engineers expressed concern that the effect of wetlands loss on native species is not considerd adequately. A discussion of the vegetation communities found on wetlands and floodplains is in the separate technical report on vegetation (ETR-14). Information about use of wetland areas for wildlife and its value as habitat are in the separate technical report on wildlife (ETR-15). Specific references are made to the value of wildlife habitat in the discussion of selected key wetlands that follows.

Ruby Marsh, also called Ruby Lake, is within Ruby Marsh National Wildlife Refuge in southwestern Elko County and northwestern White Pine County, Nevada. It covers 20,000 acres and is fed by about 135 springs at a rate of 10 to 15 thousand acre-ft per year. Another 100,000 acre-ft are contributed annually by precipitation and runoff. No permanent streams flow into the lake, and there is no outlet. The water, however, is quite fresh for a Great Basin lake (Grater, 1971). Five miles north, over a low divide, is Franklin Lake, which covers 20,000 acres. In wet years it resembles Ruby Marsh; however, it is basically a wet meadow. Most of Franklin Lake is privately owned and intensively used for irrigation, mowing hay, and grazing

livestock. Thus, it lacks the natural quality preserved at Ruby Marsh National Wildlife Refuge.

Pahranagat Valley, in Lincoln County, contains a wetland area in the bed of the pluvial White River, which has many springs with riparian and marsh vegetation. The three springs in Nevada considered most valuable by the Inventory of Natural Landmarks of the Great Basin (Bostick et al., 1975) are Ash, Crystal, and Hiko. They are all large, thermal springs, varying in temperatures from 80° to 97° F. Nevada Department of Wildlife has designated these three springs as fish sanctuaries, and several species or subspecies of threatened or endangered fish live in Ash and Crystal Springs (Pahranagat roundtail chub, White River speckled dace, and White River springfish). Ash Springs is also the type locality for several endemic aquatic insects (Bostick et al., 1975). Hiko Spring is in need of rehabilitation to reestablish native fish that were eliminated by the introduction of an exotic fish species.

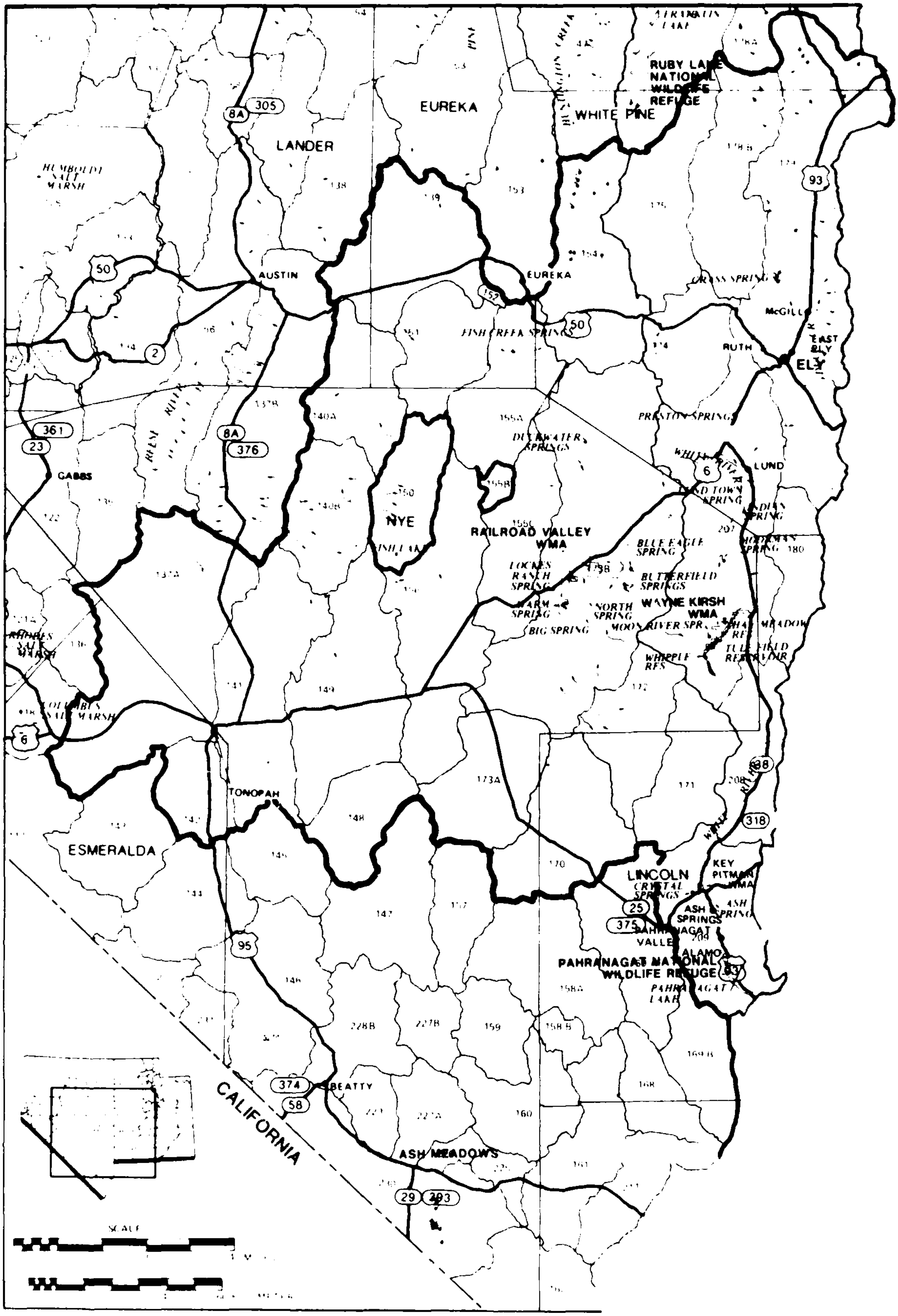
In White River Valley in Nevada, more than 37,000 acres of high quality waterfowl habitat are managed by federal and state agencies. Much of the management area consists of reservoir, marsh, and native meadow habitat. The major reservoirs and marsh areas include Adams-McGill, Dacey, Haymeadow, Tule and Old Place reservoirs and the Dacey Slough (Barngrover, 1974). Meadow vegetation, which is maintained for waterfowl habitat, includes alkali bulrush, rush, Carex, and saltgrass-black greasewood. The springs and streams feeding the reservoirs contain one, and possibly two, species of rare fish endemic to the White River: the Moormon White River springfish and possibly the White River desert sucker (at Sunnyside). Their distribution and status are discussed in the separate technical report on protected species (ETR-17).

Fish Springs National Wildlife Refuge, is located in Utah at the southern edge of the Great Salt Lake Desert and is partially surrounded by rolling dunes. Three major springs and many smaller springs have a combined flow of 45 to 50 cu ft/second (Bolen, 1964). This strong flow has inundated an area 6 mi long and 3 mi wide which is being expanded by construction of dikes and ditches to improve the habitat for waterfowl. The various plant communities of this spring-fed salt marsh form concentric zones varying in wetness and salinity. At the outer border are Distichlis communities, which extend to the edge of the sand dunes. Juncus meadows and borders separate the Distichlis complex from the permanently wet zone occupied by Phragmites and Eleocharis. Scirpus and Typha emergents border the submerged communities of Chara and Ruppia (Bolen, 1964).

The abundant waters at Fish Springs have a long history of use. The Goshute Indians intensively used these springs before European man began using them as an important way-station for explorations and later for the Pony Express. In addition, numerous but short-lived attempts were made at ranching and farming the area (Bolen, 1964). The area is presently managed by the U.S. Fish and Wildlife Service for waterfowl habitat and is primarily used for waterfowl production.

River Systems (2.1.1.2)

The Humboldt River flows east to west from the Independence Mountains to the Humboldt Sink and is the major drainage system in the northern half of the project study area. It is the only river system wholly within the Great Basin. The


EUREKA
LANDER
WHITE PINE
RUBY LAKE NATIONAL WILDLIFE REFUGE
AUSTIN
EUREKA
McGILL
EAST ELY
ELY
RUTH
LUND
GABBS
NYE
RAILROAD VALLEY WMA
WAYNE KIRSH WMA
TONOPAH
ESMERALDA
LINCOLN
KEY PITMAN WMA
ASH SPRINGS
ALAMO
PAHRANAGAT NATIONAL WILDLIFE REFUGE
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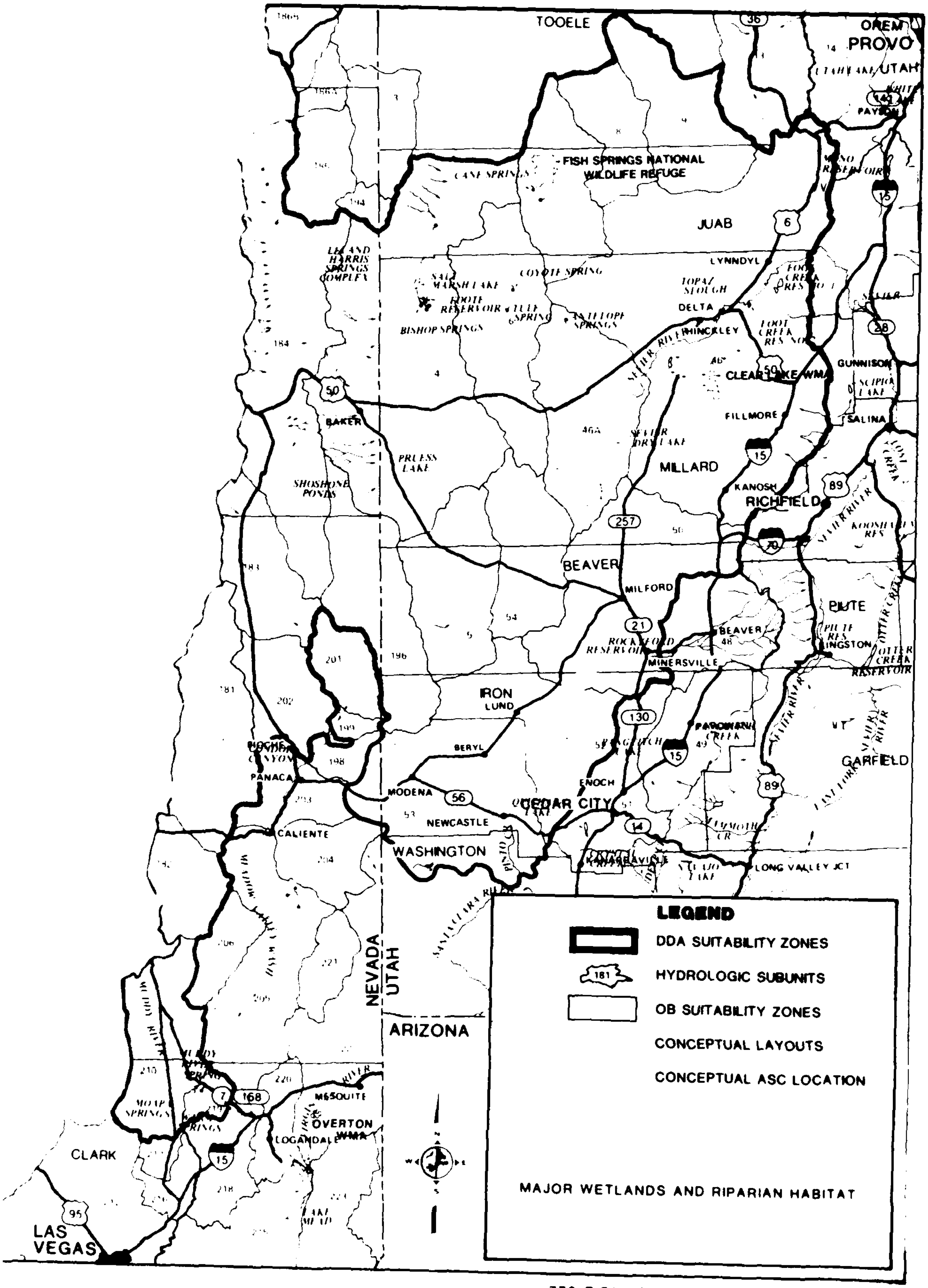

Figure 2.1-1. Major wetlands and riparian habitats in the Nevada/Utah study area.

Reese River flows north from the Toiyabe Mountains, meeting the Humboldt River near Battle Mountain. The Humboldt River has an average annual discharge of about 500,000 acre-ft per year, most of which is used for irrigation (Cronquist et al., 1972).

The earliest route across the Great Basin followed the course of the Humboldt; travel along it was particularly heavy during the gold rush in 1849 and 1850 (Bower, 1964). Bottomlands along the Humboldt River were probably the first lands in the Great Basin to be overgrazed (Frink, 1850). Much of the floodplain along the lower part of the river is now intensively managed according to approved conservation practices. These bottomlands are valuable to ranching operations in the area and are far from neglected or abused. They have been converted, however, from wild floodplain to hay fields and improved pastures.

The river course from Winnemucca to Humboldt Lake (sink) is entrenched from 10 to 20 ft. In a field visit to this area, Bostick et al. (1975) found no floodplain vegetation and saw no wildlife or wildlife habitat. They described the Rye Patch Recreation Area as "an irrigation reservoir with the usual drawdown. The residual pool is shallow and wind keeps it muddy. It is not exactly a thing of beauty, and it can't be much of a fishery either" (Bostick et al. 1975). However, Goodwin and Niering (1975) reported that a particularly interesting riparian site extending south from Rye Patch to Lovelock has considerable wildlife, and they recommended this area as suitable for registry as a natural landmark by the National Park Service.

The Virgin River, which is the other major river in the project area, flows southwest through Zion National Park in Utah and becomes part of Lake Mead near Overton, Nevada. The floodplain and flooding characteristics of the lower part of the river are largely controlled by Lake Mead water level. The Virgin River is particularly important as aquatic habitat for several rare and endangered species of fish, such as the woundfin and Virgin River roundtail chub.

Meadow Valley Wash is a small perennial stream that flows south, joining the Muddy River at Moapa, Nevada. There is well-developed riparian vegetation along its banks in several areas which supports many wildlife species, such as beaver. Native fish inhabiting this stream are speckled dace and desert sucker.

The White River is actually composed of disjunct water bodies supplied by perennial springs whose groundwater source is the carbonate rock formations of Long, Jakes, Dry Lake, Delamar, Garden, Coal, White River, Pahranagat, and Muddy River valleys. In White River Valley, surface water occurs from the headwaters in the White Pine Range to the White Pine-Nye County border and from Sunnyside Creek through Adams-McGill Reservoir. In Pahranagat Valley it flows from Crystal Spring to Alamo. Spring Valley, also part of the pluvial White River, has several artificial ponds made by the BLM at Shoshone Natural Area. At least one of these ponds is currently used as a refugium for the endangered Pahrump killifish. In both these valleys, extensive wetland areas (discussed above) are managed for wildlife.

The Sevier River system originates in the Dixie National Forest in southwestern Utah and flows north; northeast of Leamington it turns west, bends around the Canyon Mountains and heads south, ending at Sevier Lake. This lake is intermittent (a playa) because of water use for agriculture and the many reservoirs created along the river.

In the arid valleys that are suitable for M-X deployment in Nevada and Utah, aquatic habitats are limited in size and abundance. Lake Mead and Utah Lake are the only large area habitats which occur relatively close to potential siting areas. Small to moderate sized lakes (e.g., Adams-McGill Reservoir and Upper and Lower Pahranagat Lake) occur relatively infrequently throughout the study area. The Colorado River, at its nearest point to the project area, has been dammed to form Lake Mead. The Muddy River, as with the White River, is actually a disjunct water body supplied by perennial springs. Streams occur primarily in mountain canyons throughout the area, providing cold water habitat for game fish such as trout.

Spring habitats vary greatly with respect to water quality, configuration, flow rate, and accompanying aquatic and riparian vegetation. It is correct to characterize most habitats as unique, although some may be classified into basic categories. Most commonly, springs are classified as hot, cold, or fluctuating (usually according to season). Alkalinity, hardness, and dissolved solids usually vary greatly with spring source, although both turbidity and dissolved oxygen are usually low. Some spring water has been radiocarbon dated at more than 1,000 years old (since it entered the soil via precipitation) (Deacon et al., 1980). Flow can vary from a trickle to several 100 cfs, but not usually in the same spring. This defines the extent of the spring habitat. Some consist of a large spring source pool, while others have essentially no open water and a variable amount of marshy area. Most springs, however, have been altered to some extent, primarily by impoundment or diversion, for agricultural or recreational purposes. Many of these unique springs have provided an isolated habitat conducive to speciation of ancestral fish, originating from the drying Pleistocene lakes 10,000 to 20,000 years ago. They also provide water sources for wildlife.

Stream Resource Evaluation (2.1.1.3)

Stream habitats have been evaluated, ranked, and mapped by Utah and Nevada. These studies were undertaken to assist many governmental agencies in the assessment of proposed developments in light of the existing fisheries resources. Similar studies have been conducted throughout the arid West with the cooperation of the Department of Interior, Environmental Protection Agency, and the state fish and wildlife departments. Funding of these evaluations was provided by the Environmental Protection Agency, Federal Interagency Energy/Environment Research and Development Program, and Office of Energy, Minerals and Industry. The stream classification system used by each state is described below.

The Nevada Department of Wildlife has evaluated permanent streams and their tributaries and streams protected by or proposed for protection under the Wild and Scenic Rivers Act for fish habitat. Intermittent streams which are required for the maintenance of a highly valued fishery were also evaluated. Value class of each stream was designated on the following criteria: (1) occurrence of state or federal listed endangered species, (2) occurrence of state or federal listed threatened species, (3) occurrence of species of high interest to the state, and (4) possibility of habitat restoration, reclamation or mitigation. Each criterion was further divided into four value classes which describe the fish habitats present. The final value classification assigned to the habitat was the highest rating given the Criteria 1 through 3. Criterion 4 was used in only a few streams to either upgrade or downgrade the overall habitat value when the overall rating was lower than value class I.

Value class was determined for each criterion as follows (from Nevada Department of Wildlife, 1977; Wydoski and Berry, 1976):

Criterion 1: Status of State or Federal Endangered Species

Value Class I	Documented occurrence (legally defined) of any state or federally chartered endangered species.
Value Class II	Probable occurrence or past occurrence of an endangered species based on professional judgment of personnel familiar with the stream reach. It is differentiated from Value Class I by the fact that undocumented reports of the occurrence of an endangered species may be available for the reach.
Value Class III	Not applicable - only value classes I, II, and IV were used for Criterion 1.
Value Class IV	Absence or no record of any endangered species.

Criterion 2: Status of State or Federal Threatened Species

Value Class I	Documented present occurrence of a state or federally chartered threatened species.
Value Class II	Documented past occurrence and probable continued existence of a threatened species.
Value Class III	Possible occurrence of a threatened species (undocumented) including potential restocking of threatened species.
Value Class IV	Absence or no record of any threatened species.

Criterion 3: Species of High Interest

Value Class I	Habitat maintaining outstanding populations of species of high interest as defined by the State. Includes self-sustaining "wild" populations that maintain a high yield, or represent a unique esthetic, scientific, economic, educational, or recreational value.

Value Class II	Habitat that is intensively used in terms of the several requirements of a highly valued population or required habitat for less highly valued populations of a species of high interest.
Value Class III	Habitat that is occasionally used by a highly valued population of high interest or an essential habitat for maintaining a relatively low-valued population of a species of high interest. Occasionally-used habitat implies that reduction of that habitat would not seriously impair the continued existence of the population.
Value Class IV	Habitat that is not used or is sporadically or unpredictably used by species of high interest.

<u>Criterion 4: Habitat Restoration, Reclamation, or Mitigation Potential</u>

Value Class I	Current technology makes it probable that the area to be restored or reclaimed to at least an equally valued fishery as that existing prior to development. Acceptable compensation options are likely.
Value Class II	Moderate potential exists for either restoration of the habitat or reclamation to an equal-or-higher-valued fishery, or total compensation options can be defined.
Value Class III	Low potential for restoration to present species composition and population levels; however, partial compensation options can be defined.
Value Class IV	Very low or essentially no potential for restoration or reclamation of the habitat to its present species composition and population levels; no alternate resource could be introduced that would be as highly valued; no acceptable options are available to compensate for the loss of this habitat at the present time (includes stream reaches that have been designated as habitat for reintroduction of an endangered species by a National Recovery Team or State Rehabilitation Plan).

The live streams of Utah are ranked using two primary criteria: (1) the occurrence of endangered species, and the importance of species of high interest (game fish); and (2) the potential for stream restoration, reclamation, or mitigation. For endangered species, the values of critical (for documented occurrence of a species officially listed as endangered on the federal list) or high priority (for locations of probable occurrence) were assigned to streams. For species of high interest, habitat values were defined as critical (necessary for high priority areas of high species use), substantial (species exists in area but loss of habitat would not impair total species productivity), limited (species may be absent or only found occasionally), and no value (lists reaches of stream containing no fish of recreational or professional interest). Habitat numerical values were assigned to criterion number 2 after a review of the population and reproductive status of the species and the watershed and stream quality of the habitat. Numerical values were also assigned to each of the other criteria. Overall stream rating was calculated using the sum of these criterion values as shown in Table 2.1-1.

Tables 2.1-2 and 2.1-3 presents information derived from each state's Stream Resource Evaluation, in conjunction with other agency information, on creeks and rivers throughout the proposed deployment area by hydrologic subunit. These subunits and streams are shown in Figure 2.1-1.

AQUATIC BIOTA (2.1.2)

The aquatic habitats in Nevada and Utah are populated by a myriad of native and introduced life forms at all trophic levels. As Pleistocene lakes of the Great Basin dried, aquatic organisms became isolated, and the resulting disjunct populations have evolved divergently to form distinct types. This evolution is continuing, and a number of subspecies are recognized today. The nature of the pluvial lake system and its desiccation has resulted in a limited distribution of these organisms and habitats. Environmental conditions in these habitats are often rigorous and may have, in addition, little variability (e.g., constant temperature). The biological communities that have evolved in such habitats are consequently susceptible to impact from outside influences and they generally lack the ability to tolerate change in their environment or community structure. Thus, introductions of non-native species frequently reduce the amount of habitat available to native species through competition and predation, since the introduced species are usually biological generalists that easily adapt to the native conditions.

Aquatic habitats and their resident biota in the Nevada/Utah siting area have not been adequately examined to describe organism abundance, population dynamics, or habitat requirements. Intensive studies at five spring habitats, four in Nevada and one in Utah, were conducted at monthly intervals from June through September 1980 for this project. The results are included in ETR-17. These and other studies may result in the identification of several new taxa, particularly for invertebrates. Many of these organisms may need to be nominated for some type of protected status as their distribution and abundance become known. Protected aquatic species are discussed in the technical report on protected species (ETR-17).

Fish (2.1.2.1)

Although the Nevada/Utah siting area is generally arid, the limited surface waters contain a variety of fish species. Table 2.1-4 shows that approximately 90

Table 2.1-1. Ranking system for overall stream rating in Utah.

Class	Overall Rating	Description
1	31-35	Critical (Excellent)
2	25-30	Critical (Excellent)
3	18-24	High Priority (Good)
4	11-17	Substantial (Fair)
5	7-10	Limited (Poor)

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Source: Wydoski and Berry, 1976.

Table 2.1-2. Stream classification and distribution of game fish and selected nongame fish by hydrologic subunit in the Nevada/Utah study area[1] (Page 1 of 5).

Hydrologic Subunit Stream	Length (mi)	Value Class[2]	Dominant Species	Stocked
Snake Valley, Nev./Utah (#4)				
Baker Creek	9	3-I	Brook, Rainbow, Bonneville Cutthroat Trout	Annually
Deep Canyon Creek	4	2-I	Bonneville Cutthroat Trout	None
Hampton Creek	7.5	2-I	Bonneville Cutthroat Trout	None
Hendries Creek	11	2-I	Utah Cutthroat Trout	None
Lehman Creek	11	3-I	Brown, Rainbow, Bonneville Cutthroat Trout	Annually
Silver Creek	21	3-I	Brown, Rainbow, Bonneville Cutthroat Trout	None
Smith Creek	12	3-II	Rainbow Trout	None
Snake Creek	18.5	3-I	Rainbow Trout	Annually
Spring Creek	0.8	3-II	Rainbow Trout	None
Strawberry Creek	7	3-II	Brook, Rainbow, Bonneville Cutthroat Trout	None
Birch Creek	4	1	Rainbow, Bonneville Cutthroat Trout	None
Burnt Cedar Creek	5	2	Rainbow, Cutthroat Trout	None
Granite Creek	4	3	Rainbow Trout	
Thomas Creek	7	2	Rainbow Trout	None
Trout Creek	0.7	1	Rainbow, Bonneville Cutthroat Trout	None
Sevier Desert Valley, Utah (#46)				
Sevier River, in part	48	5	None	None
Sevier River, in part	12	4	Yellow Perch, Largemouth Bass, Bluegill, Walleye, White Bass, Crappie	
Oak Creek	8.5	3		Rainbow
Pioneer Creek	6.0	3		Rainbow
Chalk Creek	3.5	3/4		Rainbow
Meadow Creek	3.5	3		Rainbow
Corn Creek	9.0	3		Rainbow, Brown
Pine Creek			None	
Wild Goose Creek			None	
Maple Hollow Creek			None	
Whiskey Creek			None	
Huntington Valley, Nev. (#47)				
Box Canyon Creek	7.0	2-I	Brook, Lahontan Cutthroat Trout	
Brown Creek	6.0	3-II	Brook Trout	
Carville Creek	5.5	2-I	Lahontan Cutthroat Trout	
Cave Creek	0.3	3-II	Brook Trout	
Corral Creek	38	3-I, 3-II	Brook Trout	
Cottonwood Creek	7	3-II	Rainbow Trout	
Echo Canyon Creek	4.5	2-I	Lahontan Cutthroat Trout	
North Furlong Creek	6.3	2-I, 3-I	Brook, Lahontan Cutthroat Trout	
Gennette Creek	5.0	2-I, 3-I	Brook, Lahontan Cutthroat Trout	
Gilbert Creek	8.0	2-I, 3-I	Brook, Lahontan Cutthroat Trout	
Green Mountain Creek	11.0	2-I, 3-I	Brook, Lahontan Cutthroat Trout	
Humboldt River South Fork	28	2-II, 3-I	Brook, Lahontan Cutthroat, Rainbow Trout	Cutthroat
Kleckner Creek	9	2-I, 3-I	Brook, Lahontan Cutthroat Trout	
Lindsay Creek	11	3-III	Rainbow Trout	
Little Humboldt River, South Fork	25	2-I	Brook, Lahontan Cutthroat Trout	
Mahogany Creek	2.5	2-I	Lahontan Cutthroat Trout	
McCutcheon Creek	8.5	2-II, 3-II	Brook, Lahontan Cutthroat Trout	
Mitchell Creek	10.0	2-I	Lahontan Cutthroat Trout	Cutthroat
Pearl Creek	11.5	2-II, 3-I	Brook, Lahontan Cutthroat Trout	
Rattlesnake Creek	10.5	2-I, 3-I	Brook, Lahontan Cutthroat Trout	
Segunda Creek	3.5	2-I	Lahontan Cutthroat Trout	

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Table 2.1-2. Stream classification and distribution of game fish and selected nongame fish by hydrologic subunit in the Nevada/Utah study area[1] (Page 2 of 5).

Hydrologic Subunit Stream	Length (mi)	Value Class[2]	Dominant Species	Stocked
Seitz Creek	18	3-I	Brook Trout	
Smith Creek	22	2-I, 3-I	Brook, Lahontan Cutthroat Trout	
Ten Mile Creek	18	3-III	Brook Trout	
Toyn Creek	7	3-II	Brook, Lahontan Cutthroat Trout	
Willow Creek	12	3-II	Brook Trout	
Pine Valley, Nev. (#53)				
Humboldt River	42	3-II	Channel Catfish, Black Bullhead, Largemouth Bass, Smallmouth Bass, Bluegill Sunfish	
Carico Lake Valley (#55)				
Hall Creek	7.5	3-IV	Rainbow Trout	Rainbow
Iowa Canyon Creek	8.5	2-III	Lahontan Cutthroat Trout	Rainbow
Upper Reese River Valley (#56)				
Boone Creek	9	3-II	Brook Trout	
Clear Creek	2	III	Brook, Rainbow Trout	
Cottonwood Creek	1.2	III	Brook Trout	
Crane Creek	0.5	II	Lahontan Cutthroat Trout	
Crippen Creek	1-	3-II	Rainbow Trout	
Crum Canyon Creek	8	3-I	Brook Trout	
Elder Creek	8		Yellowstone Cutthroat, Rainbow Trout	
Illinois Creek	3.5	III	Brook Trout	
Italian Creek	10	2-II	Lahontan Cutthroat Trout	
Marysville Creek	8	III	Brook, Rainbow, Trout	
Mohawk Creek	3.5	IV	Brook, Rainbow, Brown, Lahontan Cutthroat Trout	
Reese River	15	3-II	Brook, Rainbow, Brown Trout	
Silver Creek	4.1	3-III	Brook, Rainbow, Brown, Lahontan Cutthroat Trout	
Stewart Creek	8.5	II	Brook, Rainbow, Brown, Lahontan Cutthroat Trout	
Tierney Creek	8	I	Brook, Lahontan Cutthroat Trout	
Washington Creek	9	2-I	Lahontan Cutthroat Trout	
Lower Reese River Valley, Nev. (#59)				
Humboldt River	12	III	Channel Catfish, Smallmouth Bass	
Len's Creek	8	3-I	Brook Trout	Brook
Mill Creek	18	3-I	Brook, Rainbow Trout	Rainbow
Trout Creek (a)	10	3-I	Brook Trout	Brook
Trout Creek (b)	12	3-II	Brook Trout	
Smith Creek Valley, Nev. (#134)				
Campbell Creek	8.3	3-III	Brook Trout	
Peterson Creek	6.9	3-IV	Brook, Rainbow Trout	
Smith Creek	9	3-II	Brook, Rainbow, Brown T:out	
Big Smoky Valley (North), Nev. (#137B)				
Big Creek	7	3-II	Brook, Rainbow, Brown Trout	Rainbow
Birch Creek	10	3-I	Brook, Rainbow, Brown Trout	
Bowan Creek	7.7	3-II	Brook, Rainbow Trout	
Carseley Creek	5	3-II	Brook, Rainbow Trout	
Franchmen Creek	6.3	3-IV	Brook Trout	
Kingston Creek	9.2	3-I	Lahontan Cutthroat, Brook, Rainbow, Brown Trout	Rainbow
Santa Fe Creek	5.4	2-I	Lahontan Cutthroat Trout	
Sawmill Creek	1	3-II	Brook Trout	
Shoshone Creek	2.5	2-I	Lahontan Cutthroat Trout	
Belcher Creek	6.4	III	Brook, Rainbow Trout	
Broad Creek	6.9	III	Brook, Rainbow Trout	Rainbow

T781/10-2-81/F

Table 2.1-2. Stream classification and distribution of game fish and selected nongame fish by hydrologic subunit in the Nevada/Utah study area[1] (Page 3 of 5).

Hydrologic Subunit Stream	Length (mi)	Value Class[2]	Dominant Species	Stocked
Jefferson Creek	5	IV	Brook, Rainbow, Brown Trout	Occasionally
Jett Creek	1.2	III	Brook, Rainbow, Brown Trout	Rainbow
Last Chance Creek	5.3	II	Rainbow Trout	
Moores Creek	8.9	II	Lahontan Cutthroat, Brook, Rainbow, Brown Trout	Rainbow
North Town River	7	II	Brown, Rainbow Trout	
Ophir Creek	6.6	II	Lahontan Cutthroat, Brook, Brown Trout	Rainbow
Pablo Creek	2	IV	Brook, Rainbow, Brown Trout	
Peavine Creek	6.4	II	Yellowstone Cutthroat, Brown, Rainbow, Brook Trout	Rainbow
South Twin River	7	II	Brook, Rainbow Trout	
Summit Creek	2.3	III	Brook, Rainbow Trout	
Willow Creek	0.3	IV	Brook, Rainbow Trout	
Wisconsin Creek	4.5	III	Brook, Rainbow Trout	
Grass Valley, Nev. (#138)				
Callahan Creek	3.5	3-II	Brook, Rainbow, Trout	
Cowboy Rest Creek	6	3-IV	Rainbow Trout	
Skull Creek	8.1	3-I	Brook, Rainbow, Brown Trout	
Steiner Creek	4.5	3-III	Brook Trout	
Kobeh Valley, Nev. (#139)				
Roberts Creek	8.5	3-I	Brook, Rainbow, Brown Trout	
Monitor Valley, Nev. (#140)				
Coils Creek	4.0		Rainbow Trout	
Denay Creek	3.1		Brook, Rainbow Trout	
Andrews Creek	5.7	II	Lahontan Cutthroat Trout	Cutthroat
Carley Creek	6	II	Brook, Rainbow, Brown Trout	Rainbow
Corcoran Creek	3.3	II	Rainbow, Brown Trout	
Cottonwood Creek	7.7	II	Brook, Rainbow, Brown Trout	
Meadow Canyon Creek	7.8	IV	Brook, Rainbow Trout	
Morgan Creek	4.5	IV	No fishes	
Mosquito Creek	6.4	II	Brook, Rainbow, Lahontan Cutthroat Trout	Rainbow
Pine Creek	6.4	II	Lahontan Cutthroat, Brook, Rainbow, Brown Trout	
Stoneberger Creek	7.1	III	Brook, Rainbow, Brown Trout	
Ralston Valley, Nev. (#141)				
Hunt's Canyon Creek	2.5	III	Brown, Brook Trout	
Stone Cabin Valley, Nev. (#149)				
George's Canyon Creek	1.6	IV	Brook, Lahontan Cutthroat Trout	
Little Fish Creek Valley, Nev. (#150)				
Clear Creek	4.2	III	Brook, Rainbow Trout	
Danville Creek	2	III	Brook, Rainbow Trout	
Green Monster Creek	2.7	IV	Rainbow Trout	Rainbow
Sawmill Creek	3	III	Brook Trout	
Antelope Valley, Nev. (#151)				
Allison Creek	4.5		Brook Trout	
Newark Valley, Nev. (#154)				
Hunter Creek	5.9		Brook, Rainbow Trout	
Pinto Creek	2	IV	Rainbow Trout	
Hot Creek Valley, Nev. (#156)				
Hot Creek	1.5	II	Moapa dace, Railroad Valley Springfish transplants, unnamed Tui Chub subspecies	
Six Mile Creek	[illegible]	III	Brook Trout	

Table 2.1-2. Stream classification and distribution of game fish and selected nongame fish by hydrologic subunit in the Nevada/Utah study area[1] (Page 4 of 5).

Hydrologic Subunit Stream	Length (mi)	Value Class[2]	Dominant Species	Stocked
Green Valley, Nev. (#172)				
Cherry Creek	2.8	III	Rainbow Trout	
Cottonwood Creek	2	II	Brook Trout	
Pete Hansen Creek	4.4		Brook, Rainbow Trout	
Varini Creek	6.0		Rainbow Trout	
Railroad Valley North, Nev. (#173B)				
Duckwater Creek			Unnamed Tui Chub	
Current Creek	16.1	II	Brook, Rainbow Trout	
Deep Creek	0.6	III	Rainbow Trout	
Hooper Canyon Creek	1.8	III	Brook, Rainbow Trout	
Pine Creek	2	III	Brook Trout	
Tory Canyon Creek	5.3	III	Brook Trout	
Willow Creek	0.3	IV	Rainbow Trout	
Jakes Valley, Nev. (#174)				
Illipah Creek	7.4	3-I	Brook, Rainbow, Brown Trout	
Ruby Valley, Nev. (#176)				
Battle Creek	5.0	3-II	Brook, Golden Trout	
Carter Creek	3.0	3-II	Brook Trout	
Cave Creek	0.3	3-II	Brook Trout	
Dawley Creek	3.0	3-II	Brook Trout	
Griswold Creek	2.0	3-II	Golden Trout	Golden in 1963
Lutts Creek	5	3-III	Brook Trout	
Mayhew Creek	3	3-II	Brook Trout	
Myers Creek	3	3-III	Brook Trout	
Overland Creek	6	3-I	Brook Trout	
Robinson Creek	6	3-II	Brook Trout	
Smithers Creek	7	3-I	Golden Trout	
Thompson Creek	4	3-III	Brook Trout	
Thorpe Creek	12	2-I, 3-II	Brook, Lahontan Cutthroat Trout	
Withington Creek	2.5	3-II	Brook Trout	
Wines Creek	3.5	3-II	Brook Trout	
Clover Valley, Nev. (#177)				
Gordon Creek	4.5	3-II	Rainbow Trout	
Greys Creek	3.5	3-II	Brook Trout	
Herder Creek	3.5	3-II	Brook Trout	
Horse Creek	3.5	3-II	Brook Trout	
Johnson Creek	3.5	3-II	Brook Trout	
Leach Creek	4.3	3-II	Brook Trout	
Schoer Creek	5.0	3-I	Brook Trout	
Steele Creek	4.0	3-I	Brook Trout	
Weeks Creek	4.5	3-I	Brook Trout	
Butte Valley, Nev. (#178)				
Odgers Creek			Relict Dace	
Spring Creek			Relict Dace	
Paris Creek	3.4	3-II	Brook Trout	
Taylor Creek	7	3-II	Rainbow Trout	
Steptoe Valley, Nev. (#179)				
Berry Creek	2.0	3-II	Rainbow, Brown Trout	
Lower Berry Creek	2.1	3-II	Rainbow, Brown Trout	Rainbow
Bird Creek	0.8	3-II	Brook, Rainbow Trout	Rainbow
Cave Creek	1.9	3-I	Brook, Rainbow, Brown Trout	

T781 15-2-81/F

Table 2.1-2. Stream classification and distribution of game fish and selected nongame fish by hydrologic subunit in the Nevada/Utah study area[1] (Page 5 of 5).

Hydrologic Subunit Stream	Length (mi)	Value Class[2]	Dominant Species	Stocked
Duck Creek	10.5	3-I	Brook, Rainbow, Brown Trout	Rainbow
East Creek	2.9	3-II	Brook, Rainbow, Brown Trout	Rainbow
Egan Creek	2.8	3-III	Rainbow Trout	
Goshute Creek	7.0	2-I	Bonneville Cutthroat Trout	
Big Indian Creek	6.0	3-II	Brook, Rainbow Trout	
Mattier Creek	4.0	3-II	Brook, Rainbow Trout	
McDermitt Creek	12.0	3-II	Brook, Rainbow Trout	
Nelson Creek	7.0	2-I	Cutthroat Trout	
Steptoe Creek	20.0	3-I	Brook, Brown Trout	
Tailings Creek	7.3	3-III	Brook, Rainbow, Brown Trout	Rainbow
Timber Creek	1.5	3-II	Brook, Rainbow Trout	Rainbow
Vipont (Stephena) Creek	4.0	3-II	Brook Trout	
Willow Creek	1.4	3-II	Rainbow, Brown Trout	
Spring Valley, Nev. (#184)				
Spring Valley Creek			Relict Dace	
Bastian Creek	2.8		Rainbow Trout	
Big Nigger Creek	11	3-II	Brook, Cutthroat, Rainbow, Brown Trout	
Clive Creek	19.4	3-I	Rainbow, Brown Trout	
Eight Mile Creek	3.5	3-IV	Rainbow Trout	
Kalamazoo Creek	6.9	3-I	Brook, Rainbow, Brown Trout	
McCoy Creek	4.2	3-II	Bonneville Cutthroat, Rainbow Trout	
Meadow Creek	4.4	3-II	Brook, Bonneville Cutthroat Trout	
Muncy Creek	6.6	3-II	Brook, Bonneville Cutthroat, Rainbow Trout	
North Creek	3.3	3-I	Brook, Bonneville Cutthroat, Rainbow Trout	
Odgers Creek	4.2	3-II	Bonneville Cutthroat, Rainbow Trout	
Piedmont Creek	6.7	3-I	Brook, Bonneville Cutthroat, Rainbow, Brown Trout	
Pine Creek	6	2-I	Bonneville Cutthroat Trout	
Siegel Creek	3.4	3-II	Brook Trout	
Sunkist Creek	1.3	3-II	Brook Trout	
Taft Creek	8.3	3-II	Brook, Rainbow Trout	
Willard Creek	3.5	2-I	Bonneville Cutthroat Trout	
Williams Creek	3	3-II	Rainbow Trout	
Meadow Valley, Nev. (#205)				
Meadow Valley Wash	45	IV	Bluehead Sucker, Meadow Valley Speckled Dace	
White River Valley, Nev. (#207)				
Forest Home Creek	2	III	Brown Trout	
Sunnyside Creek	6	II	Rainbow, Brown Trout	Rainbow, Brown
Water Canyon Creek	10.4	3-II	Rainbow Trout	
White River	19	3-II	Brook, Rainbow, Brown Trout	Rainbow

T781/10-2-81/F

[1]Blank spaces indicate data are unavailable.

[2]Value Class is defined on page 10 et seq.

Sources: Nevada Department of Fish and Game, 1977 ; Wydoski and Berry, 1976; Utah, State of, 1980.

Table 2.1-3. Lake and reservoir classification and distribution of fish by hydrologic subunit in the Nevada/Utah study area[1] (Page 1 of 3).

Hydrologic Subunit Lake or Reservoir	Surface Area (acres)	Value Class	Stocked Species	Other Species	Depth (ft) Maximum	Depth (ft) Mean	Temperature (°C) Maximum	Temperature (°C) Mean
Skull Valley (#10)								
Canyon Lake	36	3		Rainbow trout, Utah chub	35	17	15	
Tooele Valley (#12)								
Settlement Canyon Reservoir		3	Rainbow trout	Brown trout, black bull-head				
Great Salt Lake Desert (#32B)								
Harry Reservoir	1	3	Cutthroat trout	Brook trout	10	5		
South Fork (#46)								
Gunnison Bend Reser-voir	706	3	Walleye	Carp, white bass, channel catfish, cutthroat trout	12			
Fool Creek Reservoir 1 and 2				Yellow perch, carp, Utah chub				
Clear Lake	300	3		Carp, Utah sucker, threadfin shad				
Cherry Creek Pond		4		Brook trout, rainbow trout	8			
Near South Fork (#46)								
Deep Lake	10	4	Rainbow trout		33	18		
Big Lake	35	4	Rainbow trout		9	16		
Sevier Bridge Reser-voir		3	Walleye	Yellow perch	80			
Robins Lake	2	3	Rainbow trout					
Dixie Creek Tenmile Creek (#48)								
Puffer Lake	40	3	Rainbow and brook trout		50	6		
Manford Reservoir	3		Cutthroat trout		8			
Minersville Reservoir	284-990	2	Rainbow trout		44		22	
La Baron Reservoir	24	3	Arctic grayling, rainbow and brook trout		21			
Kents Lake Lower	7	3	Brook trout		3	2	19	
Kents Lake Middle	48	3		Rainbow trout			20	
Indian Creek Reservoir	22	3						

E28169 15-8177

Table 2.1-3. Lake and reservoir classification and distribution of fish by hydrologic subunit in the Nevada/Utah study area[1] (Page 2 of 3).

Hydrologic Subunit Lake or Reservoir	Surface Area (acres)	Value Class	Stocked Species	Other Species	Depth (ft) Maximum	Depth (ft) Mean	Temperature (°C) Maximum	Temperature (°C) Mean
Near Dixie Creek (#48)								
Paiute Reservoir	2,510	3		Rainbow trout, brown trout, Utah chub, carp, Utah sucker, redside shiner	60		19	
Otter Creek Reservoir	2,521	3	Rainbow trout	Utah chub	36		21	
Manning Meadow Reservoir	55	3	Cutthroat trout		49		22	
Box Creek Reservoir Upper	50	3	Rainbow and brook trout		18		17	
Box Creek Reservoir Lower	50	3	Rainbow and brook trout		23		18	
Three Creeks Reservoir	57	4	Rainbow trout					
Senceball	1			Cutthroat trout	5			
Otter Lake	5	3	Rainbow and brook trout				14	
Meer Lake	2	4	Rainbow trout					
Little Reservoir	4	3	Rainbow trout	Leather side chub, redside shiner	14		18	
Anderson Meadow Reservoir	8	3	Rainbow and brook trout		21		17	
Parowan Valley (#49)								
Yankee Meadow Reservoir	53	3	Rainbow and brook trout		26			
Reeds Valley Pond			Brook trout					
Paragonah Reservoir	10-57	3	Rainbow trout		33		21	
Hendrickson Lake	2	3	Brook trout		10			
Alpine Lake	1	3	Brook trout		5			
Twin Lake Upper	1		Brook trout	Cutthroat trout	4		14	
Twin Lake Lower			Brook trout		5		18	
Near Parowan Valley (#49)								
Tropic Reservoir	80-180	3	Rainbow and cutthroat trout		23		18	
Tropictown Lake	3	3		Cutthroat trout	10	7	21	
Pine Lake	77	3	Rainbow and cutthroat trout		30	12	18	
Panguitch Lake	770-1,234	1	Rainbow trout		33			

T4816/9-15-81/1

Table 2.1-3. Lake and reservoir classification and distribution of fish by hydrologic subunit in the Nevada/Utah study area[1] (Page 3 of 3).

Hydrologic Subunit Lake or Reservoir	Surface Area (acres)	Value Class	Stocked Species	Other Species	Depth (ft) Maximum	Depth (ft) Mean	Temperature (°C) Maximum	Temperature (°C) Mean
Near Cedar City Valley (#51)								
Woods Pond	1	3	Rainbow trout		6			
Mary's Creek (#52)								
Big Hollow Upper	3	3	Cutthroat and brook trout		16	6	18	
Beryl Enterprise/Pine Valleys (#53)								
Enterprise Reservoir Upper	200	3		Redside shiner	60		22	
Enterprise Reservoir Lower	80	3	Rainbow trout		98		21	
Calf Creek Reservoir	5	3		Cutthroat trout	17	2	17	
Newcastle Reservoir		3	Rainbow trout		72		4	
White River Valley (#207)								
Adams-McGill Reservoir			Rainbow, brook and brown trout, largemouth black bass, white crappie					
Pahranagat Valley (#209)								
Pahranagat Lake Upper			Largemouth black bass	Green sunfish				
Near Black Mountains Valley (#215)								
Lake Mead			Rainbow trout, silver salmon, green sunfish, channel catfish, striped bass, largemouth black bass, black crappie, bluegill, black bullhead					
Steptoe Valley (#179)								
Comins Lake			Rainbow, brown and black trout, northern pike, largemouth black bass					
Cave Lake			Rainbow, brown and black trout, northern pike, largemouth black bass					

E4816/9-15-81/F

[1]Blank spaces indicate data are unavailable.

Source: State of Utah, 1980.

Table 2.1-4. Fish of Nevada/Utah which may be affected by the M-X Project. Species classified as game fish in Nevada or Utah are so indicated (Page 1 of 4).

Species Name	Common Name
Family CLUPEIDAE	Shad and Herring
Dorosoma petenense atchafalayae	Mississippi threadfin shad
Family SALMONIDAE	Salmon, Trout, Grayling, and Whitefish
Oncorhynchus tshawythscha	Chinook salmon[1]
O. nerka kennalyi	Sockeye (kokanee) red salmon[1,2]
Salvenlinus namaycush	Lake trout[1,2]
S. fontinalis	Brook trout[1,2]
S. confluentus	Bull trout[1]
Salmo clarki	Cutthroat trout
S. c. henshawi	Lahontan cutthroat trout[3]
S. c. pleuriticus	Colorado cutthroat trout[1,2]
S. c. utah	Bonneville cutthroat trout[1,2]
S. c. lewisi	Yellowstone cutthroat trout[1,2]
S. c. gairdnari	Rainbow trout[1,2]
S. g. irideus	Southcoast rainbow trout[1]
S. g. kamloops	Kamloops rainbow trout[1]
S. aquabonita	Golden trout[1,2]
S. trutta	Brown trout[2]
Thymallus arcticus	Arctic grayling[2]
Prosopium williamsoni	Mountain whitefish[1,2]
P. gemmiferum	Bonneville cisco[2]
P. spilonotus	Bonneville whitefish[2]
P. abyssicola	Bear Lake whitefish[2]
Family ESOCIDAE	Pike
Esox lucius	Northern pike[2]
Family CATOSTOMIDAE	Suckers
Catostomus platyrhynchus	Mountainsucker
C. clarki	Desert sucker
C. discobolus	Bluehead sucker
C. marcocheilus	Largescale sucker
C. columbianus	Bridgelip sucker
C. ardens	Utah sucker
C. latipinnis	Flannelmouth sucker
C. tahoensis	Tahoe sucker

T1425/10-2-81/F

Table 2.1-4. Fish of Nevada/Utah which may be affected by the M-X Project. Species classified as game fish in Nevada or Utah are so indicated (Page 2 of 4).

Species Name	Common Name
Family CATOSTOMIDAE (continued)	Suckers (continued)
Catostomus clarki intermedius	White River desert sucker
C. fecundus	Webug sucker
C. commersoni	White sucker
Chasmistes cujus	Cui-ui
C. liorus	June sucker
Xyrauchen texanus	Razorback sucker
Family CYPRINIDAE	Carp and Minnows
Ptychocheilus oregonesis	Northern squawfish
P. lucius	Colorado squawfish
Acrocheilus alutaceus	Chiselmouth
Gila robusta jordani	Pahranagat roundtail chub
G. r. seminuda	Virgin River roundtail chub
G. r. ssp.	Moapa River roundtail
G. atraria	Utah chub
G. bicolor euchila	Fish Creek Springs tui chub
G. b. isolata	Independence Valley tui chub
G. b. newarkensis	Newark Valley tui chub
G. b. obesa	Lahontan tui chub
G. b. ssp.	Railroad Valley tui chub
G. b. ssp.	Big Smoky Valley tui chub
G. cypha	Humpback chub
G. elegans	Bonytail
G. copei	Leatherside chub
Iotichthys phlegethontis	Least chub
Richardsonius ergregius	Lahontan redshiner
R. balteatus	Redside shiner
Notemigonus crysoleucas	Golden shiner
Notropis lutrensis	Red shiner
N. stramineus	Sand shiner
Rhinichthys. osculus. robustus	Lahontan speckled dace
R. o. lethoporus	Independence Valley speckled dace
R. o. nevadensis	Nevada speckled dace
R. o. oligoporus	Clover Valley speckled dace
R. o. moapae	Moapa speckled dace
R. o. carringtoni	Snake Valley speckled dace

T1425/10-2-81/F

Table 2.1-4. Fish of Nevada/Utah which may be affected by the M-X Project. Species classified as game fish in Nevada or Utah are so indicated (Page 3 of 4).

Species Name	Common Name
Family CYPRINIDAE (continued)	Carp and Minnows (continued)
Rhinichthys osculus velifer	White River speckled dace
R. o. yarrowi	Virgin River speckled dace
R. o. ssp.	Meadow Valley Wash speckled dace
R. o. sp.	Bonneville speckled dace
R. cataractae	Longnose dace
Moapa coriacea	Moapa dace
Eremichthys acros	Desert dace
Relictus solitarius	Relict dace
Cyprinus carpio	Common carp
Carassius auratus	Goldfish
Orthodon microlepidotus	Sacramento blackfish
Lepidomedia albivallis	White River spinedace
L. mollispinis mollispinis	Virgin spinedace
L. m. pratensis	Big Spring spinedace
Plagopterus argentissimus	Woundfin
Pimephales promelas	Fathead minnow
P. vigilax	Bullhead minnow
Family ICTALURIDAE	North American Catfish
Ictalurus punctatus	Channel catfish[1,2]
I. catus	White catfish[1]
I. nebulosus	Brown bullhead[1]
I. melas	Black bullhead[1,2]
I. natalis	Yellow bullhead[2]
Pylodictis olivaris	Flathead catfish[2]
Family CYPRINODONTIDAE	Killifish
Cyprinodon nevadensis	Amargosa pupfish
C. n. pectoralis	Warm Springs pupfish
C. n. mionectes	Ash Meadows pupfish
C. diabolis	Devils Hole pupfish
Crenichthys baileyi baileyi	White River springfish
C. b. moapae	Moapa White River springfish
C. b. grandis	Hiko White River springfish
C. b. albivallis	Preston White River springfish
C. b. thermophilus	Moormon White River springfish
C. nevadae	Railroad Valley springfish
Empetrichthys latos latos	Pahrump killifish

T1425/10-2-81/F

Table 2.1-4. Fish of Nevada/Utah which may be affected by the M-X Project. Species classified as game fish in Nevada or Utah are so indicated (Page 4 of 4).

Species Name	Common Name
Family CYPRINODONTIDAE (continued)	Killifish (continued)
Fundulus kansae	Plains killifish
Family POECILIIDAE	Topminnows
Gambusia affinis	Mosquitofish
Poecilia latipinna	Sailfin molly
P. reticulata	Guppy
Xiphophorus helleri	Green swordtail
X. maculatus	Southern platyfish
Family PERCIDAE	Perch
Perca flavescens	Yellow perch[1,2]
Stizostedion vitreum vitreum	Walleye[1]
Family CENTRARCHIDAE	Sunfish
Archoplites interruptus	Sacramento perch[1,2]
Micropterus salmoides	Largemouth bass[1,2]
M. dolomieui	Smallmouth bass[1,2]
Family PERCICHTHYIDAE	
Morone saxatilis	Striped bass[1,2]
M. chrysops	White bass[1,2]
Lepomis macrochirus	Bluegill[1,2]
L. cyanellus	Green sunfish[1,2]
Pomoxis nigromaculatus	Black crappie[1,2]
P. annularis	White crappie[1,2]
Family COTTIDAE	Sculpins
Cottus beldingi	Paiute sculpin
C. bairdi semiscabei	Bonneville Baird sculpin
C. bairdi punctulatus	Colorado mottled sculpin
C. extensus	Bear Lake sculpin
C. echinatus	Utah Lake sculpin

T1425/10-2-81/F

[1]Game fish in Nevada.

[2]Game fish in Utah.

[3]Federally classified as threatened.

Source: Wydoski and Berry, 1976; State of Utah, Division of Wildlife Resources, 1980.

species have been recorded for the study area. Most of these could be affected either directly or indirectly by M-X siting in this area. About half of the fish listed are native to the area, and the majority of these native species have a status of endangered, threatened, or of special concern on state or federal lists. The native trout and suckers generally inhabit streams, rivers, or lakes while the native minnows and killifish are most often found in springs or their outflows. The other species have been introduced into many habitats, particularly those near towns or ranches.

The dominant species of fish inhabiting streams are listed in Table 2.1-2. Mountain streams contain cold water gamefish such as rainbow trout (Salmo gairdneri), brown trout (S. trutta), subspecies of cutthroat trout (S. clarki), and brook trout (Salvelinus fontinalis). These trout, particularly the rainbow, are also found in most permanent large area habitats. Cutthroat trout are the only native game fish in the study area, and in many locations the introduced trout species have out-competed or hybridized with the native cutthroats. Management policies are now changing in favor of the native cutthroat trout, and many of the existing populations are reintroductions into their historic range.

Slower moving warm water habitats, which are not as common in the siting area as cold water habitats, are populated by introduced largemouth bass (Micropterus salmoides), smallmouth bass (M. dolomieui), white bass (Morone chrysops), green and bluegill sunfish (Lepomis cyanellus and L. macrochirus), channel catfish (Ictalurus punctatus), bullheads (I. sp.), crappie (Pomoxis sp.), and yellow perch (Perca flavescens). Introduced northern pike (Esox lucius) are found in both cold and warm water habitats. Introductions of predatory game fish, such as the bass, in habitats containing native species, has often resulted in extirpation of the native fish. Many introduced, nongame fish have had a profound affect on aquatic ecosystems. Asiatic carp (Cyprinus carpio), a valuable food source in other societies, has become a nuisance fish in many habitats. This species is prolific and degrades the habitat by churning up bottom sediments in search of food. Mosquito fish (Gambusia affinis) and other topminnows introduced into many habitats in order to control aquatic insects have often resulted in the destruction of native fish populations through competition for resources, and sometimes predation on eggs or young. Other nongame fish (e.g., threadfin shad, Dorosoma petenense) have been introduced as food sources (forage) for predatory game fish.

Lower Trophic Species (2.1.2.2)

The structure and species richness for lower trophic level organisms in aquatic habitats of the project area are incompletely known. The isolated and highly variable nature of most of the perennial aquatic habitats accounts for the somewhat low diversity and high degree of endemism of many resident biota. Some groups of invertebrates are completely lacking, while others are scarce in certain habitats. For instance, bivalve molluscs are uncommon in most project area aquatic habitats, especially springs, whereas unique snails are sometimes found as the sole molluscan representative. It is postulated that snails are somehow better able to survive the rigors of the demanding habitats where they are found than are bivalves. Insect and crustacean invertebrates are more widely distributed and less unique in isolated habitats than are molluscs, since they are more easily carried in by birds and winds

(as eggs), or by flying in (as adult insects whose larval stages are aquatic). Likewise, phyto- and zooplankton are more easily dispersed by the wind or birds and, thus, are more widespread. Fast flowing spring heads are by nature depauperate of plankton as the short residence time does not allow planktonic communities to develop. Periphyton and filamentous algae, however, are often abundant and may become planktonic at times.

Organisms tolerant of the stressful water quality conditions characteristic of project area habitats include some snails, amphipods, aquatic beetles, bugs, caddis flies, and true flies (larvae). The following sediment-burrowing and desiccation-tolerant biota apparently withstand many of the stressful conditions better than other organisms: flatworms, nematodes, aquatic earthworms and sowbugs, cased and caseless caddisflies, mites, and pulmonate snails (some of which can adapt to drying conditions by closing off the opening to their shells). Some stonefly, crustacean, and phytoplankton spores and eggs can withstand long periods of drought common to portions of intermittent and fluctuating habitats.

Aquatic macrophyte vegetation includes submergent and emergent forms, such as rushes (Juncus), bulrush (Scirpus), spikerush (Eleocharis), and watercress (Rorippa). Floating and attached filamentous algae (Spirogyra, Chara, Tolypothrix tenuis, and Plectonema) and periphyton (primarily diatoms) are the dominant algal forms found in project area aquatic habitats. Phytoplankton in spring and stream habitats originate from the attached algal communities, but true phytoplankton communities may develop in lakes, reservoirs, and ponds. The permanence and structure of aquatic vegetation depends upon water level fluctuations, current, and water quality. Vegetation types may be unique in more isolated or unusual habitats, but most species can be transported throughout the area in the gut or on the feet of migratory or resident birds or in the wind as spores or seeds. Thus, most aquatic plants are similar in similar habitats, and different, in highly isolated or unique areas that support the growth of unique forms only.

Studies of lower trophic levels in five aquatic habitats of the study area were conducted in June through September 1980 and are presented in ETR-17. Knowledge regarding the species richness, habitat requirements and interactions has broadened as a result.

Game Fishing (2.1.2.3)

Sport fishing is identified as one of the most preferred modes of recreation in Nevada and Utah (Nevada State Park System, 1977 and State of Utah, 1973). There are 351,287 lake acres and 2,589 miles of stream suitable for fishing in Nevada (Nevada State Park System, 1977); in Utah, the figures are 441,400 lake acres and 3,226 miles of fishing stream (State of Utah, 1973). The area of lakes and streams within the study area is much smaller. Statewide figures are shown because current use patterns indicate willingness to travel long distances to use such resources. The increased cost of fuel has reduced the number of individual trips but has also increased the average length of stay. This change in travel pattern for fishing has not changed the upward trend in the number of fisherman-days in the more rural portions of the basing area.

Revenue for sport fishing management comes primarily from the sale of hunting and fishing licenses in Nevada and Utah (e.g., in Utah, about 90 percent of the fishing management revenue originates from this source). Fish per angler-hour estimates for both Nevada and Utah currently average approximately 3/4 to 1 fish per angler-hour for cold water species (trout, pike). There are substantially higher catch estimates for warm water species (e.g, large mouth bass, white bass, striped bass). There are no commercial fisheries in Nevada. Utah has several small commercial fisheries, but these have been encouraged by Utah State Department of Fish and Game to remove any common and typical nongame fish which are competitors of sport fish. Table 2.1-4 lists gamefish in Nevada and Utah; fishing streams are listed in Tables 2.1-5 and 2.1-6; and the number and lengths of fishing streams in the study area hydrologic subunits are shown in Table 2.1-7.

2.2 TEXAS/NEW MEXICO

AQUATIC HABITATS (2.2.1)

The Texas/New Mexico High Plains has limited surface water resources. Water-flows in stream courses are generally intermittent except in major river valleys. There are also areas of isolated springs and sink holes, primarily along the Pecos River. The flat surface of the plains and the local soil characteristics prevent drainage over wide areas; thus, much of the light rainfall flows into the playa lakes. Most of this water evaporates, with less than 10 percent percolating into the aquifers. This sequence of runoff and evaporation tends to result in slightly mineralized water, and some permanent playa lakes are saline. Adding to the natural salt concentrations are the degrading effects of irrigation return flows, oil field brine leakage, saline groundwater influx, and increased silt load from overgrazed rangeland.

The study area contains two major types of aquatic habitats: (1) river valleys and associated springs, and (2) playa lakes. The first category is represented by three drainages--the Pecos River, Canadian and Arkansas rivers, and the Red River. The first is a tributary of the Rio Grande; the others are part of the Mississippi drainage. The playa lakes are intermittent to permanent ponds forming in wind-deflation basins. They are consequently not associated with any major drainage systems. These two types of habitat are characterized by very different biota. Their locations are shown on Figure 2.2-1. Wetlands associated with many of these habitats, contrary to a comment by the Corps of Engineers, are discussed in the following paragraph.

River Systems (2.2.1.1)

The river systems support, or historically supported, various types of riparian habitat, ranging from stands of cattail (Typha) and bulrush (Scirpus) to fully developed gallery forests containing an overstory of various species of willows (Salix) and cottonwoods (Populus) and an understory of associated shrubs, grasses, and forbs. The various vegetation associations are found along both permanent and semipermanent watercourses. However, much of the riparian vegetation has suffered severe alteration, and few areas of woody vegetation remain. Most riparian areas now support only herbaceous or limited shrub cover.

Table 2.1-5. Major fishing streams and rivers in Nevada[1] (Page 1 of 2).

County	Stream
Clark County	Cold Creek Virgin River Muddy River
Elko County	Badger Creek Blue Jacket Creek Bull Run Creek Bruneau Creek Columbia Creek Humboldt (North and South Fork) River Owyhee (East Fork) Creek Jarbidge Creek Mary's Creek Lamoille Creek
Eureka, White Pine, and Lincoln counties	Roberts Creek Fish Creek Cave Creek Clover Creek Silver Creek Baker Creek Cleve Creek Lehman Creek Meadow Valley Wash Ash Springs Outflow
Lander, Pershing, and Humboldt counties	Little Humboldt River (North Fork) Martin Creek Dutch John Creek Rebel Creek McDermitt Creek Jackson Creek Kings River Creek Mill Creek Trout Creek Willow Creek Kingston Creek Steiner Creek Birch Creek Big Creek

T394/9-15-81/F

Table 2.1-5. Major fishing streams and rivers in Nevada[1] (Page 2 of 2).

County	Stream
Nye, Esmeralda, and Mineral counties	Chiatovich Creek Indian Creek South Twin Creek Barley Creek Pine Creek Reese Creek Jett Creek
Washoe, Storey, Churchill, Lyon, Carson City, and Douglas counties	Carson Creek Desert Creek Sweetwater Creek Thomas Creek Bronco Creek Galena Creek Ash Canyon Creek Clear Creek Walker Creek

T394/9-15-81/F

[1]In all, there are 2,589 mi (4,167 km) of suitable fishing streams in Nevada.

Source: Nevada State Park System, 1977.

Table 2.1-6. Major fishing streams and rivers in selected western Utah counties[1] (Page 1 of 3).

County	Stream
Garfield	E. Fork Sevier River
	Forest Creek
	Deer Creek
	Antimony Creek
	Assay Creek
	Blubber Creek
	S. Fork Sevier River
	Lost Creek
	Bear Creek
	Three Mile Creek
	Panguitch Creek
	Mammoth Creek
Iron	Castle Creek
	Louder Creek
	Asay Creek
	West Fork Asay Creek
	Clear Creek
	Bunker Creek
Juab	Trout Creek
	Birch Creek
	Granite Creek
	Burnt Cedar Creek
	Sevier River
	Chicken Creek
	Pigeon Creek
Millard	Lake Creek
	Oak Creek
	Pioneer Creek
	Chalk Creek
	North Chalk Creek
	Choke Cherry Creek
	Meadow Creek
	Corn Creek
	South Fork Corn Creek
	Maple Grove Springs

T395/9-15-81/F

Table 2.1-6. Major fishing streams and rivers in selected western Utah counties[1] (Page 2 of 3).

County	Stream
Piute	Deer Creek
	Beaver Creek
	Ten Mile Creek
	City Creek
	East Fork Sevier River
	Otter Creek
	Box Creek
	South Fork Box Creek
	Greenwich Creek
Salt Lake	Jordan River
	City Creek
	Red Butte Creek
	Parley Creek
	Mountain Dell
	Lambs Canyon
	Right Fork Lambs Canyon
	Mill Creek
	Big Cottonwood Creek
	Little Cottonwood Creek
Sanpete	Cedar Creek
	Birch Creek
	South Fork Birch Creek
	South Spring Creek
	Cottonwood Creek
Sevier	Otter Creek
	Salina Creek
	Gooseberry Creek
	Meadow Creek
	Lost Creek
	Little Lost Creek
	Glenwood Creek
	Willow Creek
	Monroe Creek
	Doxford Creek
	Dry Creek
	Clear Creek
	Fish Creek
	Shingle Creek

T395/9-15-81/F

Table 2.1-6. Major fishing streams and rivers in selected western Utah counties[1] (Page 3 of 3).

County	Stream
Tooele	South Willow Creek
	Clover Creek
Utah	Jordan River
Washington	Santa Clara River
	Water Canyon
	Leeds Creek
	Mill Creek
	North Fork Virgin River

T395/9-15-81/F

[1]Evaluations based on availability of game fish and overall rating of stream reach as per source.

Source: Wydoski and Berry, 1976.

Table 2.1-7. Number of game fishing streams and their total length for hydrologic subunits within the Nevada/Utah study area.

Subunit Number	Subunit Name	Number of Streams	Length of Streams (mi)
4	Snake, Nev./Utah	15	122
46	Sevier Desert, Utah	5	36
47	Huntington, Nev.	26	295
50	Lower Reese River, Nev.	5	60
53	Pine, Nev.	1	42
55	Carico Lake, Nev.	2	16
56	Upper Reese River, Nev.	16	108
59	Lower Reese River, Nev.	5	60
134	Smith Creek, Nev.	3	24
137b	Big Smoky-North, Nev.	23	106
138	Grass, Nev.	4	22
139	Kobeh, Nev.	1	8
140	Monitor, Nev.	11	62
141	Ralston, Nev.	1	3
149	Stone Cabin, Nev.	1	2
150	Little Fish Creek, Nev.	4	12
151	Antelope, Nev.	1	5
154	Newark, Nev.	2	8
156	Hot Creek, Nev.	2	5
172	Garden, Nev.	4	15
173b	Railroad-North, Nev.	6	26
174	Jakes, Nev.	1	7
176	Ruby, Nev.	15	65
177	Clovis, Nev.	9	36
178	Butte, Nev.	2	10
179	Steptoe, Nev.	17	93
184	Spring, Nev.	17	99
205	Meadow Valley Wash, Nev.	1	10
207	White River, Nev.	4	37

T3092/10-2-81/F

Sources: Wydoski and Berry, 1976; Nevada Department of Fish and Game, 1977; U.S. Fish & Wildlife Service, 1978.

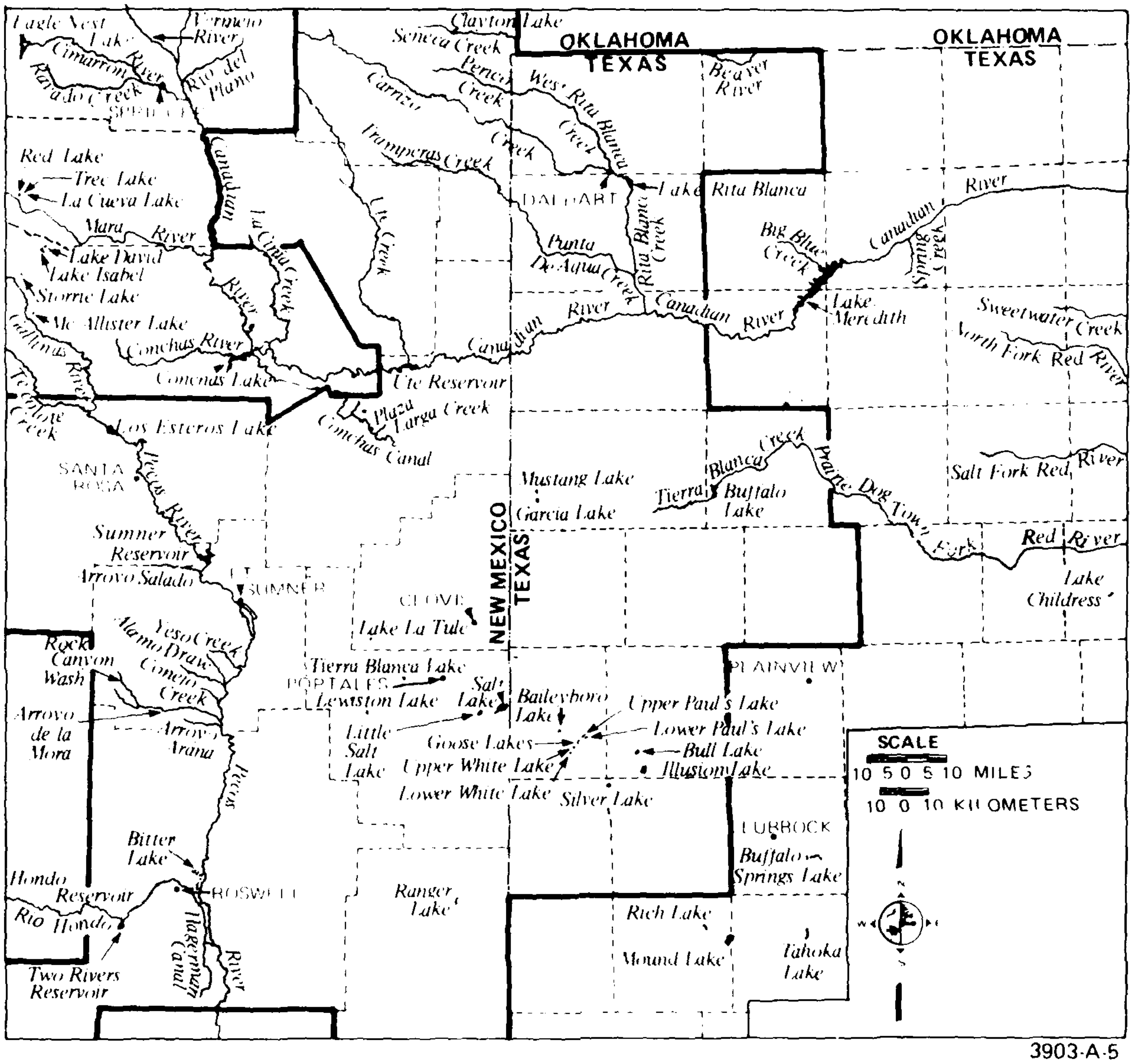

Figure 2.2-1. Playa lakes and permanent aquatic habitats in the Texas/New Mexico study area.

The general ecological importance of riparian habitat has been appreciated only recently. As the only woodland habitat present in the High Plains, it represents a vital resource to non-ground-nesting birds. Johnson et al. (1977), found that 77 percent of the nesting birds in northern Arizona, New Mexico, and west Texas were dependent on habitats associated with water. A number of the threatened and endangered birds found in the study area depend on riparian forests, including bald eagle and osprey. Although similar data on other terrestrial animals are not available, distribution maps of reptiles and amphibians (Stebbins, 1966) show strong association with river valleys, even for upland species whose need for surface water and tall vegetation is not obvious. The general scarcity of permanent aquatic habitats makes most of the associated species sensitive to any changes. Even natural changes in vegetation type drastically alter the faunal composition, as evidenced by changes in mammal species and abundance along the Rio Grande (Boeen and Schmidly, 1977). Detailed descriptions and distributions of both vegetation types and their associated terrestrial faunas are as yet unavailable.

Playa Lakes (2.2.1.2)

More important in the area are the numerous playa lakes, which are wind-deflation basins that are filled by surface runoff from rains. The lakes are variable in size, ranging from several feet to several miles in diameter, and from inches to several feet in depth (Rowell, 1971). The vast majority are intermittent, but some of the larger ones are permanent. The basins are lined with Randall clay, a fine reworked soil derived from the surrounding uplands. Because this lining is relatively impermeable, most of the water loss is evaporative. As a result, the lake basins accumulate mineral salts, and some of the permanent lakes are saline. The diversity in size, depth, and salinity makes these lakes difficult to characterize uniformly. Most lack woody or submergent vegetation, although Zanichellia palustris, Naias guadalupensis, and three species of Potamogeton have been reported from the permanent lakes. Some of the emergent species common to many of the lakes, intermittent and permanent, are Scirpus acutus, S. supinus, Typha domingensis, and species of Polygonum, Sida, Ranunculus, Eleocharis, and Heteranthera (Rowell, 1971).

The playa lakes are scattered throughout an area of intensive agriculture and, as a result, up to 85 percent of the lakes in Texas are modified to some extent (Bolen, 1980). In dry years, the small lakes are often farmed, or at least plowed, damaging the native vegetation or eliminating it altogether. Other lakes have been artifically deepened to conserve water for agricultural use or recreational fishing, for which purpose species such as channel catfish and sunfishes are stocked, along with bait animals. This deepening causes a reduction of lake surface area and loss of shallow water, drastically reducing the area of emergent vegetation (Bolen et al., 1979).

Playa lakes are the major open-water aquatic habitat of the High Plains. Large numbers of waterfowl use the lakes for overwintering. Buffalo Lake and Muleshoe National Wildlife Refuges have supported over one million ducks in peak years, and these areas represent a fraction of the total lake surface acreage. There is also evidence that mallard (Anas platyrhynchos), pintail (A. acuta), bluewinged teal (A. discors), cinnamon teal (A. cyanoptera), and redhead (Aythya americana) use the playa lakes for breeding (Bolen et al., 1979). In addition, numerous shorebird species, such as long-billed curlew (Numenius americanus) and avocet (Recurvirostra

americana), and other birds associated with water, such as sandhill cranes (Grus canadensis), marsh hawks (Circus cyaneus), and Mississippi kites (Ictinia mississippiensis) utilize the playas. These waterfowl are supported by seeds from emergent vegetation, especially wild millet (Echinochloa crus-galli) and tearthumb (Polygonum spp.), and invertebrate populations, primarily phyllopod crustaceans such as clam shrimp (Lynceus brevifrons, Caenesteriella setosa), tadpole shrimp (Triops longicaudatus), and fairy shrimp (Streptocephalus texanus, S. dorothae) (Sublette and Sublette, 1967). The lakes also support populations of aquatic beetles, corixids, midges, snails, worms, and other invertebrates in smaller numbers than the crustaceans. Spadefoot toads (Scaphiopus spp.) and salamanders (Ambystoma tigrinum) use the playa lakes for breeding; there is some evidence that young waterfowl feed on both invertebrates and tadpoles.

Modified playas (i.e., those modified for agricultural purposes) are less suitable for waterfowl than unmodified ones for several reasons. The area of emergent vegetation on unmodified lakes can be 24 times as large as on modified lakes, providing far more cover and food for herbivorous species, such as blue-winged teal (Rollo and Bolen, 1969). There is also a strong correlation between area of emergent vegetation and invertebrate abundance, and a strong correlation between invertebrate abundance and brood production. Interestingly, intermittent lakes consistently supported higher invertebrate biomass than permanent lakes. Thus, unmodified intermittent playa lakes provide the best available habitat for waterfowl, both breeding and wintering, on the High Plains (Bolen et al., 1979).

Since the Texas High Plains are clean farmed, most of the available wildlife cover is provided by the vegetation associated with playa lakes. Pheasants (Phasianus colchicus), cottontails (Sylvilagus spp.), and raccoons (Procyon lotor) use this vegetative cover (Bolen et al., 1979). Playa lakes also serve as water sources for terrestrial animals. Pronghorn (Antilocapra americana) abundance was historically correlated with playa water. Unfortunately, quantitative data on use of the playas by wildlife are lacking, although more studies are underway.

Virtually nothing is known of the status of these lakes in the New Mexico High Plains region. As the area is primarily rangeland, agricultural modifications are unlikely. However, intensive use by range cattle can cause severe damage to the native vegetation (Bolen et al., 1979), so it is possible that the playas in New Mexico are as threatened by range use as are those in Texas by intensive agriculture.

AQUATIC BIOTA (2.2.2)

Fish (2.2.2.1)

Approximately 75 species of fishes have been reported from the Texas/New Mexico High Plains study area. As can be seen in Table 2.2-1, many of the species are common to all three river systems and in fact are found throughout drainages east of the Rockies. Even the one species in the study area considered by Texas to be threatened, the blue sucker (Cycleptus elongatus), is common elsewhere in the Mississippi drainage. A number of the species in the Pecos River, which also inhabit the Canadian and Red rivers, have been introduced; examples of these are yellow perch (Perca flavescens) and various sunfishes (Lepomis spp.). The Canadian and Red rivers, as part of the Mississippi drainage, have nearly identical fish faunas.

Table 2.2-1. Fish of the Texas/New Mexico study area (Page 1 of 2).

Species Name	Common Name	Status[4]	Drainage		
			P[1]	C[2]	R[3]
Lepistosteus spatula	alligator gar	S,Cm			X
L. osseus	longnose gar	S,Cm			X
Dorosoma cepedianum	gizzard shad		X	X	X
Esox lucius	northern pike	S		X	X
Hiodon alosoides	goldeye			X	X
Ictiobus bubalus	smallmouth buffalo	S,Cm	X		X
I. cyprinellus	bigmouth buffalo	S,Cm			X
I. niger	black buffalo		X		X
Carpiodes carpio	river carpsucker	Cm	X	X	X
Catostomus commersoni	white sucker		X	X	
Cyprinus carpio	carp	S,Cm	X	X	X
Gila nigrescens	Rio Grande chub		X	X	
Chrosomus erythrogaster	redbelly dace			X	
Semotilus atromaculatus	creek chub		X	X	
Hybopsis gracilis	flathead chub		X	X	
H. aestivalis	speckled chub		X	X	X
Hybognathus placitus	plains minnow		X	X	X
H. nuchalis	silvery minnow				X
Pimephalus vigilax	bullhead minnow	Cm			X
P. promelas	fathead minnow	Cm	X	X	X
Campostoma anomalus	stoneroller		X	X	X
Carassius auratus	goldfish			X	X
Notropis jemezanus	Rio Grande shiner		X		
N. lutrensis	red shiner	Cm	X	X	X
N. stramineus	sand shiner	Cm	X	X	X
N. percobromus	plains shiner				X
N. oxyrhynchus	sharpnose shiner			X	
N. blennius	river shiner			X	X
N. potteri	chub shiner			X	X
N. buccula	smalleye shiner			X	
N. venustus	blacktail shiner	Cm		X	
N. volucellus	mimic shiner			X	
N. buchanani	ghost shiner			X	
N. bairdi	Red River shiner				X
Notemigonus chrysoleucas	golden shiner	Cm		X	X
Ictalurus punctatus	channel catfish	S,Cm	X	X	X
I. furcatus	blue catfish	S,Cm	X	X	X
Ictalurus melas	black bullhead	S,Cm	X	X	X
I. natalis	yellow bullhead	S,Cm	X	X	X
I. lupus	headwater catfish		X		
Noturus gyrinus	tadpole madtom			X	
Pylodictis olivaris	flathead catfish		X	X	X
Fundulus kansae	plains killifish		X	X	X
F. zebrinus	southwestern killifish		X		

T1199A/10-2-81/F

Table 2.2-1. Fish of the Texas/New Mexico study area (Page 2 of 2).

Species Name	Common Name	Status[4]	Drainage P[1]	C[2]	R[3]
Cyprinodon rubrofluviatilis	Red River pupfish			X	X
Gambusia affinis	mosquitofish		X	X	
Morone chrysops	white bass	Cm		X	X
M. saxatilis	striped bass	S	X		
Micropterus salmoides	largemouth bass	S			
M. punctulatus	spotted bass	S	X		X
Lepomis gulosus	warmouth	S	X	X	
L. auritus	yellowbelly sunfish	S			X
L. cyanellus	green sunfish	S		X	X
L. punctatus	spotted sunfish			X	
L. microlophus	redear sunfish	S	X	X	X
L. macrochirus	bluegill	S	X	X	X
L. humilis	orange-spotted sunfish	S		X	X
L. megalotis	longear sunfish	S	X	X	X
Poxomis annularis	white crappie	S	X	X	
P. nigromaculatus	black crappie	S	X		
Perca flavescans	yellow perch	S	X		
E. spectabile	orangethroat darter			X	
Stizostedion vitreum	walleye			X	
Percina caprodea	logperch			X	X
Aplodinotus grunniens	freshwater drum	S,Cm		X	X
Moxostoma congestum	gray redhorse		X		X

T1199A/10-2-81/F

[1]P = Pecos River

[2]C = Canadian and Arkansas rivers

[3]R = Red River

[4]S = Sport; Cm = Commercial

Sources: Koster, 1957; Lee et al., 1980.

However, the Pecos River, a tributary of the Rio Grande, has a number of distinguishing species including some endemics restricted to springs and seeps in the Pecos Valley but not in the river proper. The Rio Grande drainage species are roundnose minnow (Dionda episcopa), Rio Grande shiner (Notropis jemezanus), and bigscale logperch (Percina macrolepida). The Pecos River endemic species, Pecos pupfish (Cyprinodon sp.) and Pecos gambusia (Gambusia nobilis), are restricted to sinkholes and clear-water springs, perhaps forced into these refugia by the deteriorated water quality of the major streams. All are found at Bitter Lake National Wildlife Refuge, and have populations in isolated springs and sinkholes elsewhere.

Thirty species of fish in the area have some commercial or sport value (see Table 2.2-1). However, since many of the aquatic habitats are highly mineralized or intermittent, production of preferred game or food fish is not favorable. The existing populations of larger fish are often dominated by generally undesirable species such as gizzard shad (Dorosoma cepedianum), carp (Cyprinus carpio), carpsucker (Carpiodes carpio), and gray redhorse (Moxostoma congestum). Populations of sunfishes (Lepomis spp.) and catfishes (Ictalurus spp.), which are desirable as food species (Lewis, 1957), occur in some areas.

Lower Trophic Species (2.2.2.2)

The invertebrate faunas of aquatic habitats in the Texas/New Mexico study area are not well-studied, but some general observations can be made. Mollusks, some species of crustaceans, and numerous species of larval and adult insects are the dominant invertebrates to be encountered in aquatic environments of the region. The high salt content and/or the intermittent nature of many of the waters probably restricts the diversity of freshwater invertebrate species present. Organisms tolerant of low-to-moderate salt concentration would include several species of phyllopod crustaceans, snails (Gastropoda), scuds (Amphipoda), and aquatic insects represented primarily by species of beetles (Coleoptera), bugs (Hemiptera), caddisflies (Trichoptera) and flies (Diptera) (Pennak, 1978). Although many of the water bodies in the area are intermittent, they do retain water for varying periods of time. Such water bodies often function as refuges for some species and as temporary habitat for others. These would include aquatic invertebrates such as species that survive by burrowing into the substrate. This group is comprised of flatworms (Turbellaria), nematodes (Nematoda), aquatic earthworms (Oligochaeta), crayfish (Decapoda), scuds and aquatic sowbugs (Isopoda), small crustaceans, beetles, some caseless caddisflies, and some midges (Chironomidae), snails, and mites (Acari). Species such as phyllopod crustaceans and stoneflies (Plecoptera), whose eggs or immature forms are able to survive long periods of drought may be found. These water bodies may include species that reinvade from elsewhere as soon as water returns such as certain mayflies (Ephemeroptera) and blackflies (Simulidae). Species such as certain mosquitoes (Culicidae), midges and other flies, beetles, and a variety of bugs that occupy pools or the damp parts of a stream bed only during the dry period or during the early stages of the dry period may also survive in these water bodies. Highly specialized inhabitants of temporary waters, such as a few snails and caddisflies, have adapted to the dry conditions by closing off the opening to their shells or cases.

Fishing (2.2.2.3)

Ponds, playas, and lakes of less than 40 surface acres are the primary fishing habitats in the Texas and New Mexico High Plains study area; 25 percent of the playas are thought to contain significant amounts of water throughout the year. In a special 1976 report prepared by the U.S. Department of Agriculture in cooperation with several Texas agencies, it was assumed that ponds primarily on private lands are generally not open for public use, and that only 48 percent of the fishing habitat in the High Plains is accessible to the public. The report estimates a need in the High Plains for 1,600 surface acres of lakes in 1975 to 2,500 acres in 2020 to meet the expected fishing demand.

Recent fisheries management studies of permanent impoundments in the Texas High Plains (Kraai, 1974, 1976a, b) found over thirty species present in the region, many of which were introduced as sportfishes or food for sportfishes. Some of these populations seem self-sustaining when reservoir levels remain fairly constant, but recent dry years have resulted in reduced populations to the point where stocking has been required to maintain the fishery. No catch records were presented in these studies.

Most fish species caught for sport are introduced and are shown in Table 2.2-1, designated with an S. Although Texas records are not available, the New Mexico Department of Game and Fish keeps records of total harvest, not broken down by species. For 1978, the most recent data available, Ute Lake yielded roughly 263,000 fishes, Lake Sumner 21,000, and the rest of the Pecos drainage in the study area, 233,000 (Patterson, 1981).

3.0 PROJECT IMPACTS

3.1 NEVADA/UTAH

Siting M-X in the Nevada/Utah area would impact aquatic habitats and species through construction activities, system operation, and increased numbers of people in the area. Table 3.1-1 provides a summary of potential impacts. The types of impacts expected include degradation of surface water quality, physical alteration of aquatic habitats, and reductions in surface water volume and surface area resulting from groundwater withdrawal. Each would have the potential to cause significant adverse impacts to aquatic species. The Nevada Department of Transportation states that "if or when heavy withdrawal from the groundwater basin occurs and the springs that feed the wetland start to dry up, the M-X project will be in direct violation of Executive Order 11990 -- Protection of the long and short-term impacts associated with the destruction or modification of wetlands." However, the Air Force will avoid impacting wetlands to the extent possible. Mitigations are discussed in Section 3.3.

CONSTRUCTION (3.1.1)

As estimated in the technical report on water resources, the maximum annual water use for construction activities would be approximately 27,000 acre-ft (3.35×10^7 cu m). Since such volumes are not available as surface resources, groundwater resources would be required. All types of project-related development (including roads and urban centers) would require withdrawal of water from aquifers either within the valleys utilized or from nearby valleys which have a large perennial yield that is not currently allocated. An example of a valley which has a large, unused perennial yield is Spring Valley. Its estimated perennial yield is from 70,000 to 100,000 acre-ft per year (8.7 to 12.4×10^7 cu m/yr) (Rush and Kazmi, 1965).

Groundwater withdrawal could impact aquatic habitats on a site-specific basis throughout the siting area if well placement and operation are not accurately engineered and managed. The extent and significance of the potential impacts from groundwater withdrawal would be expected to be minimized through good management practices. However, in some geographically limited areas, where project intensity is high and the available water (perennial yield minus current use) is low, there would be a potential for significant impacts to aquatic habitats, particularly those in valley bottoms. As a result of slow soil/rock transmissivities, impacts could occur several years after water withdrawal for construction. (For more specific information on groundwater withdrawal and potential impact location, see ETR-12 on water resources.) Many topographically closed valleys in the deployment area are hydrologically connected to other valley systems. This is particularly apparent in the valleys surrounding the White River/Muddy (Moapa) River system (Eakin, 1966). Increased groundwater withdrawal in any valley could result in a decrease in water volume for springs which are in the cone of depression around the withdrawal point. Valley bottom habitats would be the most likely to be affected while little or no effect could be expected for those in the mountains. Affected perennial streams would be expected to show a decrease in length and stream flow while water levels in groundwater-fed lakes and ponds could be lowered. Groundwater mining in areas where several valleys are hydrologically connected could result in impacts to aquatic habitats a considerable distance away from the point of withdrawal, even in

Table 3.1-1. Summary of potential general project effects on aquatic species, Nevada/Utah (Page 1 of 2).

Project Parameter	Related Effects	Impacts on Aquatic Species	References
	Construction		
Area disturbed	Fugitive dust	Minimal impacts predicted.	
	Erosion and siltation	Chemicals in rainfall runoff from new asphalt roads, cement production, dust suppression activities, and accidental petrochemical spills could temporarily impact some protected organisms. Saltation in aquatic habitats could be locally important. All species (both game and nongame species population could be reduced, Phytoplankton and periphyton productivity decreased, gill breathing and filter-feeding organisms smothered or starved.	Deacon et al., 1979; Hynes 1966; Cummins and Klug, 1979 Armour, 1977; Hutchinson and Collins, 1978; Phillips et al., 1975; Platts, 1979
	Loss of vegetation	Destruction of aquatic habitat and its associated vegetation could destroy endemic fish populations and reduce game fish productivity.	Pister, 1974; Platts, 1979; Armour, 1977
	Presence of machinery and people	Minimal impact predicted other than those discussed in recreation.	
	Operations		
	Fugitive dust	Minimal impacts predicted.	
	Erosion	Some impact similar to construction but at a lower level.	
	Revegetation of disturbed areas	Beneficial impact would result by decreasing erosion/sedimentation and reestablishing conditions similar to those of the preproject.	Keller et al., 1979
	Transmission lines	No impact predicted	
Water use	Lowering of water table	Valley bottom habitat reduction or loss and extinction or extirpation of isolated populations. Mitigation by transplanting or alteration of well water pumping rates and/or location.	Deacon et al., 1979; Minckley and Deacon, 1968; Hardy, undated.

T2352/10-2-81

Table 3.1-1. Summary of potential general project effects on aquatic species, Nevada/Utah (Page 2 of 2).

Project Parameter	Related Effects	Impacts on Aquatic Species	References
Water use (cont.)		Feeding and spawning habitat reduced.	Williams, 1977; Fiero and Maxey, 1970; Bateman et al., 1974; Dudley and Larsen, 1976; Pister, 1974.
Vehicle traffic	Fugitive dust	Minimal impacts predicted.	
People	Sewage	In habitats near area of rapid population growth, some reduction in water quality is expected, e.g., Ely, Alamo, Moapa, and Delta. Nuisance algal blooms expected.	
	Solid waste	None predicted.	
	Introduction of exotic species	Nonnative may outcompete endemic aquatic species, may introduce and eliminate endemics through habitat competition and/or diseases.	Deacon et al., 1979; Walstrom, 1973, Hickman and Duff, 1978; Minckley et al., 1977.
Operations			
During construction, people will be dispersed throughout deployment area. During operations people and effects will be concentrated in the vicinity of operating bases.	Recreation ORV use	Increases access to pristine *habitats*. Damages benthic sediments. Locally increased turbidity and degraded water quality due to waste disposal. (See erosion and siltation.)	Walstrom, 1973
	Camping and hiking	Trampling of pristine areas, waste disposal and littering can result in local erosion/sedimentation and water pollution problems.	Walstrom, 1973
	Fishing	Possible depletion of native cutthroat trout by preferential capture. Further depletion by increased fishing pressure.	Dieringer, 1980; Walstrom, 1973
	Poaching	Similar to normal fishing pressure but less intense.	
	Swimming	Disturbance of species behavior, increased turbidity, habitat deterioration. Loss of desirability of fishery.	Walstrom, 1973; Manning, 1979.

T2352/10-2-81

other valleys which are topographically isolated from the point of withdrawal. As a result of physical changes to aquatic habitats, many biotic features would be expected to change. The generalized loss of habitat could result in the loss of specific portions (small features) within each habitat (Dudley and Larsen, 1976). Many of these small features (e.g., ledges in springs) have been demonstrated to be critical for the existence and maintenance of small populations of native organisms. Lowering of the surface levels of springs, lakes, and ponds would be expected to adversely alter many species' interactions (e.g., predation and competition) because of the loss of spatial segregation in the water column. The temperature of spring water may change. Pond and lake area reductions would reduce the migratory waterfowl habitat available. The changes in water level would modify several physical factors of aquatic habitats (e.g., temperature profile, light penetration, flow rates) which are commonly controlling factors of growth of lower trophic level organisms (Hutchinson, 1967).

Many of the valleys proposed for extensive groundwater withdrawal have significant habitats that should be protected from impact. As an example, the pluvial White River system, as a hydrologic groundwater system, has three valleys listed as possibly containing sufficient amounts of groundwater to supply the needs of a missile shelter prefabrication site (Fugro, 1980). These valleys are Coal, Garden, and White River. These valleys, along with Long, Jakes, Dry Lake, Delamar, Cover, Pahranagat, Kane Springs, Coyote Spring, and the Moapa valleys, form the hydrological unit which supplies the water source to the springs and streams of the White River, Pahranagat, and Moapa valleys. Withdrawal upgradient, in this case generally northward, would result in loss of groundwater flow lower in the groundwater unit. Withdrawals from upper White River, Coal and/or Garden Valley would be expected to result in a decrease in flow in the springs of Pahranagat Valley, such as Ash and Crystal Springs. If the volume of water withdrawn were high enough in White River Valley the ten springs inhabited by native species would be expected to have decreased flow and loss of habitat. The ten springs contain four species protected by federal or state laws (Hardy, undated). In addition, these springs contain ten other species recommended for protection by regional authorities. Water withdrawal which resulted in the loss of these habitats would be an important impact to the native protected fauna. Groundwater withdrawal from some of the proposed IOC valleys (Dry Lake and Delamar) would also influence spring and valley bottom stream habitats in Pahranagat, Coyote Spring and Moapa valleys. Modification of aquatic habitats in the White River hydrologic system would impact the White River springfish (Crenichthys baileyi ssp.), spinedace (Lepidomedia albivallis), desert sucker (Pantosteous clarki), and speckled dace (Rhinichthys osculus velifer); the Pahranagat roundtail chub (Gila robusta jordani); the Moapa River roundtail (G.r ssp.); the Moapa dace (Moapa coriacea); and the Moapa River speckled dace (R.o. moapa). Expected impacts to these and other protected species are described in ETR-17 (Protected Species).

Physical alteration of aquatic habitats resulting from construction activities, other than those affecting water quality or resulting from groundwater withdrawal, would be limited to the direct use of machinery in aquatic habitats. The loss of aquatic habitats from physical alteration should be limited in extent and potentially significant in only a few isolated cases. Streambeds and downstream flow regimes would be disturbed or temporarily reduced during construction of road crossings (e.g., bridges, culverts, or fords). This would destroy the aquatic habitat by covering benthic communities and/or desiccating other aquatic biota. Operation of heavy

machinery near sensitive springs, many of which are very small in size, could cause collapse of their overhung banks, thereby destroying a substantial amount of aquatic habitat.

Many of the projected activities related to M-X construction would increase erosion rates and, therefore, sediment loading of downstream or downslope aquatic systems. With the exception of DTN segments through the mountains, such impacts would occur primarily in a few valley bottom springs or reservoirs. Most valley bottom aquatic habitats in the Great Basin when undisturbed have very clear waters. An influx of suspended sediment would increase turbidity and sedimentation in these habitats which would adversely affect resident biota. Respiration of fish and invertebrates could be impaired by clogging of their gills, visual feeding would be reduced, benthic sediments would be altered, and primary productivity of algae and submerged macrophytes would be reduced. Most soil redistribution processes, particularly those near streambeds, would result in an increase in sediment load of nearby aquatic environments. Areas where native groundcover has been removed, thereby exposing the soil to larger erosive forces, would be a major source of sediment. Likewise, areas of cut and fill operations would be regions of high erosion potential. Any required changes to stream channels, such as stream crossings and channel relocation projects, would release large amounts of sediment. Temporary impoundment and/or diversion of stream flows from one channel to another would be expected to increase stream sediment carrying capacity as a result of increased stream velocities.

An increase in sediment load from the construction activities described above, although limited in geographical extent, would be regarded as a negative and potentially significant impact to aquatic habitats and communities. Streams with heavy suspended sediment loads are less aesthetically appealing to anglers and other recreationists (Manning, 1979). In addition, fine grain sediment deposition in spawning areas impedes the flow of dissolved oxygen through the intragravel spaces. This causes the developing embryos to become oxygen-starved and allows the accumulation of metabolic wastes (Phillips et al., 1975). Sediment deposition also fills instream cover (gravel interstices) which are vital to the survival of young fish as protection from predation (Platts, 1979). High erosion of streambanks results in the physical loss of bank habitat and the transport of portions of the habitat and organisms downstream. Upon deposition, all in situ benthic life would be covered with a layer of unconsolidated material. This would not only result in the death of most of the benthic biota but would also result in the loss of some habitats required by fish (e.g., gravel bottom spawning grounds). Further loss of streambanks, particularly in smaller streams, would also adversely impact fish population densities (Platts, 1979). Fish use streambank edge habitat for cover (riparian vegetation), control of water velocity, and as a source of incoming terrestrial foods. The addition of sediment to aquatic systems would result in changes to the trophic and community structures in these habitats (Kaster and Jacobi, 1978). Mobile organisms which require hard substrates would be crowded and would, thereby, be subject to increased predation; nonmobile organisms would be buried by settled sediment. Siltation would cause changes in species composition (Platts, 1979). The bottom organisms would suffocate and algal growth would slow. The addition of sediment to surface water would result in water quality changes, particularly in pH and total dissolved solids (TDS) (Varma, 1979). Finally, the diversion of waters from one source into another watercourse could result in the accidental transfer of non-native species from one habitat to another. Unplanned introductions of nonnative

species would significantly impact the native biota on a site-specific basis (Hardy, undated). All of the above listed impacts are currently affecting aquatic communities in the study area. Deployment of the M-X system would be expected to accelerate the trend of habitat degradation.

Construction activities would be expected to increase the introduction of other pollutants. Most of these pollutants can be contained or treated to reduce potential impacts. These pollutants (e.g., oils and herbicides), although occurring during construction activities in small amounts, would be expected to have a higher incidence of occurrence during the longer operational phase. A more complete discussion of these impacts can be found below.

Indirect impacts to aquatic habitats during construction would result primarily from the increased number of people present in formerly sparsely settled areas. Construction of additional housing, transportation networks, and their attendant features (e.g., parking lots) would reduce the groundwater recharge potential through covering the soil with impervious surfaces or recompaction of soils. This would increase local erosion potential by increasing runoff volumes and velocities. Increases in runoff volume and velocities would be expected to result in an increase in water volumes which would eventually rest in the bajadas of each watershed. The bajadas are areas of high evaporative loss and low infiltration. Therefore, these waters would be lost to the normal groundwater recharge system. (For fuller explanation of the hydrologic system, see the water resources technical report, ETR-12.)

Recreational activities are likely to concentrate near or in aquatic habitats causing additional impacts. Water quality would be adversely impacted by non-point source pollutants, runoff of suspended sediments from upstream watershed use for recreational activities (particularly ORVs), and possible overloading of existing wastewater treatment facilities. (Construction of new wastewater treatment facilities are currently planned for the proposed OBs.) Aquatic habitats would also be physically impacted because of increased human contact for various recreational purposes. Existing game fishing areas would experience a significant increase in fishing pressure. This increased pressure would probably require enhanced stocking of native and introduced game fish to supplement native fish yield. The introduction of exotic fish through stocking for recreation or release of unwanted aquarium fish would result in an extremely adverse impact to native fish, and increased protection of native fish habitats may be required or some native fish species may be extirpated (Hardy, undated; Dieringer, 1980). Deliberately and accidentally introduced nonnative fish species have been one of the key factors in the dramatic trend of native species extinctions and reductions that have occurred in the southwest in the past century. All aquatic habitats are likely to receive some increase in recreational pressure and contamination during the construction period. State fish hatcheries are presently operating at peak capacity and probably cannot support an expanded stocking program to meet the needs of new residents. Old, unused hatcheries in Utah would have to be put back into operation after expensive upgrading, or new hatcheries would need to be built in order to meet the increased fishing demands brought by M-X deployment.

OPERATIONS (3.1.2)

Operation of the proposed M-X system would have the same types of impacts to aquatic habitats and species as those listed for construction activities; however, the intensity and exact location of these impacts would be modified. Groundwater withdrawal would be principally limited to waters used for domestic needs. This is estimated to be a maximum of approximately 10,000 acre-ft/year (1.24×10^7 cu m) or approximately 37 percent of the maximum one-year use during construction. Furthermore, water use during operations would be concentrated near the OBs and support communities with lesser amounts used at the dispersed support facilities (e.g., security stations).

No direct physical alteration of aquatic habitats would be expected from operational activities. Indirect physical impacts should be similar but more intense than those listed under construction, particularly near the OBs where recreational use would be expected to be higher. This would cause more recreational pressure on the limited aquatic habitats and resources. Prior construction activities affecting habitat quality, particularly sedimentation, would be expected to continue impacting aquatic species during operations.

Pollutants, other than sediments listed under construction, which could adversely impact local water quality, would be introduced to aquatic systems from centralized point sources or from dispersed areas (non-point sources). The expected point sources would be from domestic wastewater outfalls at the OBs and support communities, increasing the nutrient load and oxygen demand on downstream habitats, and from industrial processes discharging effluent with elevated temperature and a wide variety of dissolved and suspended particulate wastewaters. Such industrial sources would be very localized and are most likely to be in areas already having industrial development. Non-point source pollutants would originate from a wide range of land use options, including parking lots, roads, lawn irrigation, and air pollution fallout. These would also be concentrated in the vicinity of the OBs and support communities but could also occur throughout the potential deployment area as a result of project maintenance and operation. The composition of these pollutants is as varied as their sources, encompassing oils, greases, solvents, pesticides, human excrement, dusts, heavy metals, and salts.

Domestic wastewater discharges would be expected to be controlled through the proper application of existing technologies. Since water is a scarce commodity in much of the Great Basin, wastewater sources could be used to the advantage of the area surrounding the OBs through reclamation. The accidental or occasional direct discharge of treated domestic wastewaters to aquatic habitats would locally accelerate the eutrophication process through the addition of soluble nutrients, particularly nitrogen and phosphorus. Eutrophication of the aquatic habitat would result in major changes in aquatic community structure, loss of aesthetic appeal of the watercourse, degradation of the fishery, and proliferation of nuisance species, such as decaying algal mats (Hutchinson, 1967).

Collection, treatment, and reuse of discharge of industrial effluents would be somewhat more difficult and expensive than for typical domestic wastewater (Fox and Treweek, 1980). Industrial effluents produced by M-X operational acitivities would be small in volume and limited to OB locations with DAAs. As a result of the diversity and unpredictability of pollutant species in plausible effluents, detailed

impact analysis of each industrial effluent is not possible at this time. However, determination of certain generic impacts is possible. Although these pollutants would be very limited in volume, they could pose a significant threat to aquatic systems. Introduction of thermal effluents to cold-water habitats could dramatically impact the resident biota, since an increase in water temperature would increase community metabolic rate while decreasing dissolved oxygen levels. Thermal effluents may be reused for heating or industrial processes, or they may be cooled before discharging to existing surface waters. Many other industrial pollutants would not be expected to be immediately recycleable. Hazardous wastes would be required to be contained and disposed of in an approved manner. Introduction of oils, solvents, hazardous fluids, radioactive materials, heavy metals, mining spoils, combustion by-products and all other toxic contaminants, although very rare in occurrence, would result in significant impacts to the aquatic ecosystem (Hutchinson and Collins, 1978). Each pollutant species would have its own particular impact.

Non-point-source pollutants, although rarely as concentrated as point-source pollutants, could pose as significant a potential impact as many of the direct effluent sources. Since most of the non-point-source pollutants are the same types as those identified above in industrial effluents, impacts would probably be similar. Because non-point source pollutants are rarely concentrated, treatment or removal of these pollutants would be both difficult and expensive.

Impacts to game fish habitats, and therefore game fishing, during operations, would include impacts from other recreational uses of aquatic habitats that cause physical habitat disturbance, sedimentation, degradation of water quality, elevation of ambient temperature, and possible reduction of water volumes. Number of anglers per fishing resource area will increase in some areas, and decreased fishing quality (as measured either by fishing success or aesthetic quality of the fishing experience) could result if management activities are not implemented to compensate for increased pressure (Manning, 1979; Adriano, 1980; Dieringer, 1980).

The game fishery would be expected to experience increased fishing pressure from construction workers and support personnel (Dieringer, 1980). Fishing has been identified as one of the most preferred recreational activities by residents of both states (Nevada State Park System, 1977; and Utah Outdoor Recreation Agency, 1978). Due to the limited number of fishable waters in Nevada and Utah, the fishing quality is likely to decrease without additional management. In Nevada, fish hatcheries at Reno (2), Las Vegas (1), Ely (1), and Ruby Marshes (1), are now operating at their limit and public waters are presently stocked to their limit (Dieringer, 1980).

Based on the most recent (1977) state population data and numbers of state resident fishing licenses held, it is expected that the increase in population resulting from M-X construction and operation would increase the number of licensed fishermen by 2.8 percent in 1987 and 2.65 percent in 1994. While there is expected to be an increase in the number of people and fishermen as a result of M-X, it is difficult to accurately assess the specific effects on fishing. The range of the effects is based on the degree of disturbance. However, without an increase in fish stocking rates and in fish habitat resource, fishing success in both states would decrease with the increased population associated with M-X. Regardless of how many fish are stocked in a given water body, there would be a loss of fishing quality

due to a loss of the aesthetic quality of the fishing experience with increased numbers of anglers (Manning, 1979).

Indirect effects due to M-X construction and operation could include changes in fishery management policies (e.g., reduced bag limits, decreased number of fish stocked per angler, increased put and take fishing, and increased catch and release fishing) (Dieringer, 1980; Adriano, 1980).

Increased population associated with M-X could result in increased law enforcement needs relating to fishing (e.g., increased poaching, disturbance of native fish habitats, and introduction of exotic species). Increased law enforcement activity due to large influxes of construction personnel have already been experienced in Nevada during periods of large operations at Nellis Air Force Base (Dieringer, 1980).

In White Pine County, it is estimated that full Nevada/Utah deployment would result in the need for up to fifteen new enforcement officers. The siting of an operating base in Steptoe Valley, near Ely, would further increase the demand for new enforcement personnel (McLelland, 1980). The illegal taking of fish would be expected to follow a similar trend as has been found in Elko County over the last five years as a result of an upswing in mining activities in that county. Citations processed for violations of wildlife laws in that county have increased 70 percent in the last five years (Greenley, 1980).

The Department of Wildlife in Nevada and the Department of Wildlife Resources in Utah receive federal support for their sport fishing management programs. The Dingell-Johnson Program matches state money on a 3:1 basis for nonconsumptive uses (e.g., land acquisition, research). The money cannot be spent on fish production, stocking, or law enforcement. States could acquire a limited amount of land under the Dingell-Johnson Program to set up new sport fisheries. As soon as the fishery becomes established, however, federal money could no longer be used. The money presently allocated by the states for nonconsumptive uses would be insufficient to maintain any additional sport fishing resource habitat (Dieringer, 1980; Adriano, 1980).

EFFECTS ON PROTECTED SPECIES (3.1.3)

A detailed analysis of protected aquatic species resources and potential impacts is presented in the technical report on protected species (ETR-17).

3.2 TEXAS/NEW MEXICO

Impacts on aquatic habitats and species fall into two categories: direct impacts from construction and operations. Indirect impacts would result during both of these phases from increased human population (Table 3.2-1).

CONSTRUCTION (3.2.1)

The river valleys would not be significantly impacted by construction because they are not geotechnically suitable for siting. Consequently, there would be little or no loss of this habitat assuming mining of gravel would not take place in the rivers. Some playa lakes in the Texas/New Mexico area, however, would be

Table 3.2-1. Summary of potential impacts on aquatic habitats and species in the Texas/New Mexico study area (Page 1 of 2).

Project Parameter	Related Effects	Potential Impacts: Aquatic Habitat	Potential Impacts: Aquatic Species
Area disturbed	Construction:		
	Land used for shelters, DTN.	Loss of small playa lakes too shallow to impede construction; alteration of sheet runoff, water supply to playa lakes.	Loss of habitat for amphibians, invertebrates.
	Loss of vegetation.	Increased erosional silt load added to agricultural runoff causing increased turbidity, burial of some benthic habitat.	Reduction of primary productivity. Loss of food to higher trophic levels.
	Spilled petro-chemicals, construction materials, industrial waste.	Introduction of toxic material to riverine systems, where they will eventually disperse, and playa lakes, where they will accumulate.	Effects ranging from behavioral interference to acute lethal effects, depending on pollutant, concentration, and exposure time.
	Operations:		
	Revegetation of unused disturbed areas.	Reduced erosional silt load close to pre-project levels; potential restoration of buried stream bottoms.	Increase in hard-bottom species.
Water use		No effects.	No effects.
Vehicle traffic		No effects.	No effects.
People	Sewage	Possible pollution of streams, depending on methods of wastewater treatment and disposal; if nutrient load increases, can expect localized eutrophication.	If eutrophication occurs, population decline with increase in algal growth, oxygen demand.

T3006/9-16-81/F

Table 3.2-1. Summary of potential impacts on aquatic habitats and species in the Texas/New-Mexico study area (Page 2 of 2).

Project Parameter	Related Effects	Potential Impacts: Aquatic Habitat	Potential Impacts: Aquatic Species
	Solid waste	No effects.	No effects.
	Introduction of species	No effects.	No effects; most warm water game species introduced already.
	Recreation:		
	ORV use	Disturbance of dry playa lake beds; destruction of stream bottoms at fords, with increased siltation downstream.	Loss of vegetation cover used as food by waterfowl and invertebrates when flooded; population reduction at fords, downstream.
	Fishing	No effect on habitat per se.	Increased fishing pressure on native and introduced game fishes.

T3006/9-16-81/F

disturbed by the interference with surface water flow caused by road and shelter construction. Some smaller playas may be eliminated by construction activities (e.g., near Bailey County, Texas). Water used for the construction and operation phases of the project would not adversely influence the playa lakes because the fossil-water Ogallala aquifer does not interact with the surface water system in the deployment area. In contrast to the Utah/Nevada situation, deployment of M-X in the Texas/New Mexico area would leave surface waters essentially unaffected. Water used during construction could be cleaned and possibly reinjected into the Ogallala aquifer or discharged into the playa lakes.

Direct impacts of construction on the river systems derive from alteration of the land surface on adjacent geotechnically suitable uplands. Such impacts could occur in the Canadian River and some of its tributaries in Dallam and Hartley counties (Texas) and Union and Quay counties (New Mexico). Several tributaries of the Red and Brazos rivers, such as Palo Duro and Tierra Blanca in Deaf Smith County and the Running Water in Parmer County, could also be affected. Portions of the Pecos River in De Baca County would be near construction activities as well. Runoff from rains could increase and would result in heavier loads of silt than normal due to loss of vegetative cover (Branson et al., 1972). This causes increased sediment load and turbidity in receiving waters and in turn results in burial of benthic habitat which may have been previously unsilted (Cummins and Klug, 1979). Riffle areas in upper waters of the Pecos and Canadian rivers drainage could also be affected.

The channel catfish populations that are found in most of these areas could be influenced by the potential loss of some of their primary food sources (insects and algae (La Rivers, 1962)) due to the increased sedimentation. In addition, turbidity would also reduce primary productivity, both benthic and water-column, by reducing available light, causing an overall reduction in biomass and a change in species composition in the affected area (Hynes, 1976). Siltation from project-related construction would have significant effects only in areas currently unfarmed because in farmed areas M-X would affect a very small area compared to the surrounding area regularly tilled. Since the silt load in most of these waters is already high due to present uses the effect of siltation from M-X construction is not likely to be significant.

Pollution from machinery such as spilled petrochemicals, construction materials, and industrial waste from on-site manufacture, could also enter the riverine systems. Most petrochemicals used as fuels have varying degrees of toxicity to life in receiving waters, ranging from interference with chemosensory systems in fishes to lethal toxicity. If sufficiently concentrated, a combination of pollutants with increased sediment load could alter the aquatic biota noticeably. Impacts would be site-specific and would be identified in analyses for subsequent tiered decisionmaking. They would be controlled through implementation of a variety of spill containment and "clean" construction techniques.

Playa lakes would be affected by M-X construction differently than the riverine systems. The playas not directly in the path of construction activities would experience increased sediment loads and inputs of petrochemicals and other pollutants from DTN and shelter construction. Since playa lakes are naturally turbid, they would be less affected by siltation than other systems. However, pollutants not naturally degraded will remain in the playa sediments because playa

lakes do not drain into other water bodies or underlying aquifers. This results in concentration of toxic materials over time, with potentially damaging effects.

The presence of roads and shelters also alters surface runoff patterns, affecting water flow into individual playa lakes. These lakes depend entirely on diffuse runoff from rains for water supply. Inlet streams are rare because most of the water flows in sheets (Sublette and Sublette, 1967). Without mitigation, construction activities could result in changes in runoff drastic enought to deprive larger lakes of water supply sufficient to support large numbers of migrating and wintering waterfowl.

Although the larger playas are clearly unsuitable for roads, shelters, or base accommodations, the small playas may suffer alteration or destruction during construction activities if they are not deep enough to prevent construction of roads or shelters in or near them. Although comparatively unimportant for wildfowl use, smaller playas do provide breeding grounds for local spadefoot toad populations, which do not use permanent water bodies for reproduction.

OPERATIONS (3.2.2)

Once construction is completed, some of the potential impacts should be greatly decreased. Cessation of soil disturbance should result in reductions of both sediment load and accompanying pollutants. The riverine systems should be able to return to a state similar to that prior to construction. Sediment in runoff to playa lakes not directly altered or destroyed by construction should decrease gradually to preconstruction levels as revegetation occurs. However, any accumulated sediments and pollutants would remain. Alteration of runoff patterns would also be permanent, causing changes in water available to given lakes. During operations, runoff of pollutants, such as spilled gasoline and engine oil, would generally be localized to maintenance areas and could be prevented by using standard containment procedures. Runoff of pollutants from roadways should be small compared to that occurring from existing roads in this area. Direct impacts experienced during operation should differ in magnitude, but not type, from construction impacts.

Direct impacts result in alteration or elimination of habitat, which in turn leads to reduction of populations of aquatic species in affected areas. Increased sediment load in streams and rivers resulting from M-X construction activities would not be expected to alter clear-water habitats sufficiently to cause reduction or loss of populations of aquatic species, such as certain minnows and darters and clear-water, gravelbottom invertebrates. Increased sediment load on playa lakes would result in an increase in the rate that the basins refill with sediment, leading to their disappearance. This varies widely from lake to lake, and might be reversed by wind deflation, the same process that formed the lakes.

The effects of introduced pollutants tends to differ between riverine habitats and playa lakes. In riverine systems, depending on stream flow, concentration, solubility, and other chemical properties of the pollutants, accumulations differ from habitat to habitat. In general, concentrations of pollutants decrease with distance from the source and with time. Potential chronic or acute toxic effects on living organisms basins, experience increasing concentrations of pollutants over time with increasing likelihood of toxic effects on the biota. Some pollutants would also

concentrate in higher levels of the food chain, potentially threatening reproducing waterfowl which feed on the playa lake invertebrates and plants.

The degree of threat to any given aquatic system depends on the specific pollutants. These are difficult to ascertain at this time, but general statements can be made. (As noted above, riverine systems could be affected in only a few locations, while individual playa lakes could be affected throughout the potential deployment area.) Many pollutants, such as oils, and pesticides, and heavy metals tend to persist in aquatic systems and are often toxic in varying concentrations. Water collection and treatment could dramatically reduce impacts from these pollutants.

Adverse environmental effects of all of these are expected to increase with time in the playa lakes, but not necessarily in the riverine system, and could be enhanced by M-X activities. However, in agricultural areas, sedimentation and introduction of pesticides, herbicides and nutrients from fertilizers are currently high and would outweigh effects from M-X construction and operation. Implementation of measures to reduce sedimentation (e.g., revegetation immediately after construction activities) and the accidental application of pollutants (e.g., controlled use of petro- and other chemicals) will minimize these M-X-related effects. In general impacts from non-point source pollutants are not expected to be significant but, if mitigation measures were not carefully implemented, these could significantly impact specific locations, such as playa lakes (and possibly riverine habitats in the Canadian River drainage).

Nontoxic pollutants from wastewater discharges (e.g., high nutrient loads causing increased oxygen demand and potential eutrophication downstream) (Fair, Geyer and Okun, 1966, 1968) and power plant discharges (elevated temperatures and, perhaps, high dissolved salts) are not expected to have significant impacts since wastewater disposal or reuse facilities proposed to support such systems are available locally.

Indirect impacts would be expected due to an increase in local human populations. Construction of housing would cause the same type of impact as missile site construction. Because an already existing base is proposed for the operations center, and because several large towns exist at the periphery of the deployment area, indirect effects on aquatic systems due to increased housing would not be great, provided the total work force is distributed widely. In addition, recreational pressure on the surrounding countryside is expected to increase, particularly in the vicinity of the OBs. Use of ORVs in river valleys could add sediment load to the streams, or, if heavy enough, damage stream beds. This would be most likely to occur in the vicinity of the Dalhart OB. Indiscriminate ORV use could also damage upland vegetation, causing erosion and siltation. ORV use in dry or drying playa lake beds could damage emergent aquatic vegetation, destroying cover for birds and small mammals and removing an important source of detritus for the aquatic system. Waterfowl hunting on playa lakes, with the possibility of poaching, would be expected to increase. An increase in game fishing, with accompanying pressure to stock exotic species, might also occur. This increases competitive pressure on native species, and may cause drastic population reductions. For example, introduction of exotics and water quality degradation in the Pecos River appears to have eliminated the Pecos gambusia from much of its former

habitat. Additional reacreational pressures would be greatest during construction and would decrease during the operations phase.

M-X operation in not expected to exert a significant long-term effect on the fisheries resources in the Texas/New Mexico area. However, fishing pressure within and surrounding the DDA would increase in proportion to the direct and indirect project-related population growth. Total population in the M-X deployment area is estimated to increase 13 percent during construction and 5 percent during operations for the full basing alternative in this area. Consequently, there might be a decline in angler success in many locations corresponding to project-related population increases. The reservoirs and rivers within the DDA that would probably receive the most use are: Lake Rita Blanca (near Dalhart, Texas) which has been stocked in the past with rainbow trout, brown trout, channel catfish and largmouth bass; Alamagordo Lake (south of Santa Rosa, New Mexico) that has crappie, bass and catfish; and the Canadian and Pecos Rivers both with channel catfish. There are several other areas outside the DDA that would receive increased fishing pressure. These include: Lake Meredith (north of Amarillo, Texas); Greenbelt Reservoir (near Clarendon, Texas) with, as of 1974, the only northern pike fishery in Texas; the cold water trout streams and rivers near Santa Fe and Taos, New Mexico in the Santa Fe National Forest; and the trout streams in the mountains near Carrizozo, New Mexico. Increased fishing pressure is discussed in recreation section of ETR-41.

Because of the increased fishing pressure, management policies might have to be altered and new policies implemented. Measures that may possibly decrease impacts on fisheries resources include reduced bag limits, shorter seasons, increased put and take fishing, and increased catch and release fishing. Impacts may also be reduced by the 10 percent excise tax levied on fishing gear manufacturers by the Dingell-Johnson Act. This act matches state money on a 3:1 basis for habitat acquisition, development, improvement and research. Perhaps more fishery development could occur within and around the DDA because of the projected growth in population. The Dingell-Johnson Act, however, does not support stocking or wildlife law enforcement so funding for these activities will have to be acquired elsewhere.

EFFECTS ON PROTECTED SPECIES (3.2.3)

A detailed analysis of protected aquatic species resources and potential impacts is presented in the technical report on protected species (ETR-17).

3.3 MITIGATIONS

The major impacts to aquatic species would be the result of habitat degradation due to a variety of causes as a result of the project. These impacts would occur primarily as a result of habitat loss from groundwater withdrawal, habitat loss and/or degradation caused by increased sedimentation and/or turbidity, increased stress to sensitive habitats and species due to increased recreation, introduction of exotic species, habitat alteration due to eutrophication from waste water discharge, pollution of sensitive habitats by exotic chemicals, and habitat loss from surface water withdrawal. Additionally, impacts to floodplains and wetlands could be evident due to M-X placement and construction effects.

Mitigation measures will be directed toward minimizing these impacts.

AIR FORCE PROGRAMS (3.3.1)

The Air Force will institute a cooperative program with appropriate federal and state management agencies for aquatic species and will institute educational programs for workers and their dependents. The cooperative program would include all or part of the following as appropriate: avoid important habitats if possible, schedule activities to avoid critical periods, assist enforcement and management agencies, transplant species and provide additional habitat or alter other habitats to offset impacts.

OTHER MITIGATIONS UNDER CONSIDERATION (3.3.2)

Habitat Loss from Groundwater Withdrawal (3.3.2.1)

Water use for construction and operation of various phases and facilities of the M-X project will utilize groundwater aquifers that may provide discharge for springs and streams either nearby or distant from the point(s) of withdrawal. The degree to which groundwater withdrawal affects a sensitive aquatic habitat will depend upon the amount, rate, and location from which the water was withdrawn. The direction of groundwater flow, the supply or perennial yield of the aquifer, and the existing transmissivity and fault structure of the aquifer strata determine the magnitude and the time lag of effect. Water supply for each spring or stream is unique, with a wide variety of water quality types occurring in the Great Basin. From a thermal aspect alone, springs are known to exist virtually side-by-side, one of which is considered hot and the other cold (e.g., Ash Springs in Pahranagat Valley). In other valleys, such as Railroad, a series of cold springs occur on the eastern side of the valley apparently following an ancient fault line, whereas, on the western side of the valley, two clusters of hot springs occur less than 30 mi apart.

Habitat loss from groundwater withdrawal will result in reduced carrying capacity of the habitat for sensitive aquatic species. For fish, this could result in crowding, loss of spawning habitat, and loss of substrate from which food organisms such as algae and invertebrates grow. At Devils Hole in Ash Meadows, Nevada, it was shown that reduction of water exposed a previously submerged ledge which provided both feeding and spawning habitat for the Devils Hole pupfish. It was shown that this loss of habitat caused a gradual decrease in the population levels of the formerly stable community of pupfish. When the water level at Devils Hole was re-established at preexisting conditions, the population of pupfish returned to former levels of abundance.

There are several potential mitigations that could be included to reduce the impact of habitat loss from groundwater withdrawal. One measure could be to avoid upslope well locations near sensitive aquatic habitats. Several likely mitigations may be employed to ameliorate impacts of groundwater pumping upon nearby and distant aquatic habitats. Monitoring of habitat conditions during pumping may indicate that pumping rates can be adjusted to maintain adequate levels of spring flow and still provide for construction and operation water needs. For instance, pumping rates could be increased during spring flow and still provide for construction and operation water needs. For instance, pumping rates could be increased during spring snowmelt runoff conditions; conversely, since springtime is critical for spawning of sensitive fish species, it may be this time of year when reductions of water levels would be most critical. During midsummer when aquifer

production is lowest, pumping near sensitive aquatic habitats should also be reduced in order to prevent complete desiccation of the habitats.

Another possible measure could be the interim augmentation of spring flow. In aquatic habitats located more distant from pumping fields, it may be observed that water-level reductions occur much later after initiation of pumping. Since recovery of spring-flow rates may also take a relatively long time, it may be necessary for interim augmentation of spring flow which is not immediately mitigatable by changing of pumping rates or locations. In such a situation, it may be recommended that water of a similar quality be piped in from a nearby nonconnected source, or even from the same aquifer source. For instance, a well drilled adjacent to a spring and tapping the same aquifer as the spring could be utilized as a source to supplement spring flow until normal spring flow is reestablished. This is a difficult strategy requiring careful planning and control so that the spring habitat does not become dependent on the supplementation from the piped-in water.

Another potential mitigation to well-water withdrawal from an aquifer would be to recharge that aquifer with treated domestic wastewater from life support camps and operating bases. This mitigation would be limited by the difficulty in recharging an aquifer over several hundred feet deep and the natural tendency of evaporative loss of the wastewater before it is injected into the groundwater as a result of the arid desert climate.

A final mitigation, when all other mitigations prove ineffective, would be to transplant affected sensitive species to compatible habitats not affected by groundwater withdrawal. This is exceedingly difficult and requires trial-and-error experiments, since habitat requirements for many desert aquatic species are unique and essentially unknown. Successful implementation of this mitigation would require early contingency planning including early identification of habitats and species that may be jepoardized, characterization of critical environmental parameter (including water quality, flow, food and spawning requirements) surveys to identify suitable sites for transplantation, possible modifications of transplant sites to accomodate requirements of the transplanted species, and early transplantation to establish the new population before the source habitat becomes unable to support the species. Since a large proportion of spring habitats in the Great Basin already contain endemic biota, selection of receiving habitats for transplantation requires consideration of impacts to the endemic biota may be caused by the transplantation.

Habitat Loss Caused by Increased Sedimentation (3.3.2.2)

Structures such as DTN, cluster roads,and shelters may be constructed near aquatic habitats. Depending upon the slope and proximity of the constructon, erosion followed by increased turbidity and sediment load in aquatic habitats is possible. Since no project structure will be constructed directly over perennial aquatic habitats for geotechnical reasons, it is not expected that direct physical disturbance such as major channelization or clearing of aquatic vegetation will occur.

Increased sedimentation and/or turbidity can cause habitat loss and/or degradation. Habitat loss will result in impacts discussed previously. Habitat degradation such as increased turbidity could also stress affected sensitive aquatic

biological populations. Some fish require clear water for feeding and increased turbidity could cause starvation. Increased turbidity could also suffocate food organisms such as filter-feeding and breathing benthic macroinvertebrates. Suffocation of fish directly via clogged gills could result from increased water turbidity.

There are two potential mitigation measures that could reduce the impact of habitat loss and/or degradation caused by increased sedimentation and/or turbidity. The primary mitigation would be to avoid siting upslope from sensitive aquatic habitats and if this is not possible, utilization of erosion prevention measures. Dams, weirs, erosion netting, and revegetation can aid in prevention of erosion. Reinforcement of bridge and culvert structures which are nonobstructive to water flow patterns would also be helpful in eliminating enhanced surface erosion and subsequent down-slope sedimentation and turbidity in aquatic habitats.

Another potential measure could be to schedule construction near and upslope from sensitive aquatic habitats after the major expected rainfall season. If sedimentation of sensitive aquatic habitats cannot be avoided, the affected aquatic habitats could be restored, rehabilitated, or enhanced as soon as possible before adverse reductions or resident species occur.

Increased Stress to Habitats due to Increased Recreation (3.3.2.3)

An expected accompaniment to any large project in relatively pristine environments is the incursion of recreational pursuits some of which were previously unknown for the region. The Great Basin and much of the Texas/New Mexico High Plains is relatively sparsely populated. New construction and operation personnel, their families, and support personnel can be expected to pursue a variety of recreational activities. Attractive aquatic habitats provide diversion in the form of swimming, fishing, camping and even gold panning. Many habitats can be reached only by foot, horseback, or offroad vehicle (ORV).

Populations of the sensitive aquatic species occurring in attractive aquatic habitats subject to recreation would experience stress from disturbances to which they are unaccustomed. It can be expected that many of the aquatic species will adapt to multiple use of their habitat for recreation; however, if this recreation damages part of the habitat or disturbs them during a particularly critical or sensitive part of their life cycle, they may be unable to cope, and subsequently decline in abundance. Swimming can disturb spawning activities as well as feeding, whereas fishing can remove a major portion of a resource, such as trout. Camping, in itself, should not disturb sensitive aquatic species unless waste materials are disposed into the aquatic habitat which degrades its quality. Gold panning in a trout stream could reduce water quality by increasing turbidity. Some endemic trout are particularly sensitive to increased turbidity and may be seriously affected by this pastime activity. ORV use can irreversibly disturb the sediments and gravel substrates of a small stream or spring. This increases turbidity and reduces a production of benthic macroinvertebrates which are important food for many sensitive aquatic species.

Increased recreational fishing pressures may extend to those habitats containing the Lahontan and Bonneville Cutthroat trout. These increased pressures might be mitigated by increasing stocking programs and habitat improvements. Restricted fishing in certain critically impacted streams may be required.

There are two potential mitigation measures that could be included to reduce the impact of increased stress to sensitive habitats and species due to increased recreation. Since recreation is a highly dispersed activity, it would be difficult to protect every sensitive aquatic habitat from recreational incursion. A practical mitigation could be to educate construction workers and those associated with operation of the facility with the sensitivity and uniqueness of the aquatic biota inhabiting many of the more prominent and attractive aquatic habitats in the project area. Those habitats considered most sensitive to recreational habitat disturbance may require fencing and protection by an onsite resource manager.

Introduction of Exotic Species (3.3.2.4)

Exotic species are those which do not normally occur in an area. These include introduced aquarium species such as goldfish, mollies, and swordtails, and pest-control species such as mosquitofish, plus game species such as hybrid trout, bass, sunfish, and even carp.

Exotic species bring with them their aggressiveness to populate a habitat with their own kind and, possibly, a whole new host of diseases, which may infect endemic species. It has been shown that some exotic species have been highly successful in eliminating endemics (e.g., mosquitofish, carp, and trout). Goldfish are now common in numerous springs throughout the Great Basin and compete for food with the endemic species.

There are two potential mitigations that could reduce the impact of introduction of exotic species. One of the primary mitigations to introduction of exotic species is the education of the public to the harm or damage to endemic species that they may be causing by introducing these species. Where public education is ineffective, fencing of the aquatic habitat and stationing of an onsite manager may be required.

Another measure could be to renovate aquatic habitats. Once an aquatic habitat has been contaminated by exotic species, it may be necessary to renovate or remove those exotic species. This is usually quite difficult and requires careful collection of endemics from the present mixed population, after which the entire habitat is poisoned, with a short-lived toxin, and endemics are reintroduced. Invariably, some of the exotic species are not killed, and return in abundance at some later date. Renovating the habitat may also require placement of weirs downstream to prevent the upstream movement of undesirable exotics. This has been undertaken at Hot Creek in White River Valley, where bass have been removed from head springs to prevent extirpation of the Moormon White River springfish.

Habitat Alteration from Wastewater Discharge (3.3.2.5)

Near centers of population growth, wastewater disposal may create a problem in nearby surface waters. Treated domestic wastewater can enrich receiving waters and change the species composition of the resident biota. This is especially evident where the receiving water is of relatively small volume and does not sufficiently dilute the wastewater which is discharged into it.

Eutrophication, nutrient enrichment and oxygen reduction of receiving water as a result of wastewater discharge can alter species composition, especially at the

lower trophic levels. Certain sensitive aquatic species such as fish may find that a primary food source is eliminated as a result of wastewater discharges. If the species is unable to adapt to the new food source, it may suffer starvation. Wastewater discharges, even treated, may also deplete the oxygen in the surface water, especially at night time and in heated waters so that the endemic species are unable to survive. Many existing aquatic habitats in the Great Basin are characterized by relatively low oxygen levels. Resident species have adapted to low oxygen levels but are approaching their limits of tolerance. Any further reduction in dissolved oxygen levels, even very small reductions, could eliminate certain sensitive aquatic species.

One potential mitigation that could be included to reduce the impact of habitat alteration due to entrophication from wastewater discharge could be advanced waste treatment or lagooning. Domestic wastewater which is discharged into a small volume receiving water would require advanced treatment to reduce the oxygen demand and nutrient levels of materials discharged. Since this is probably prohibitively expensive, it may be prudent to avoid discharge of domestic wastewaters into sensitive aquatic habitats by injecting them deep into distant aquifers or by simply allowing the wastewater to evaporate from lagoons and removing the sludge to land fills. Wastewater may also be used to settle construction dust or be recycled for domestic use.

Pollution of Habitats by Exotic Chemicals (3.3.2.6)

Near construction sites where activity of trucks, tractors, and machinery is high, there is the probability that oil or gasoline spills will occur as a result of machinery breakdowns, etc. These chemicals, thus, could enter surface waters as a result of heavy rainfall. Construction materials such as cement and iron oxides could also enter surface waters during rainfall.

Introduction of exotic chemicals into pristine, sensitive aquatic habitats could seriously threaten populations occuring therein. The toxicity of petrochemicals is usually high to unacclimated species. Information on susceptibility, specific to species occurring in the project areas, is presently unavailable. Less toxic construction materials, such as cement or iron oxides, could reduce habitat quality by increasing turbidity.

There are two potential mitigations that could be included to reduce the impact of pollution of sensitive habitats by exotic chemicals. Introduction of construction materials into surface water habitats could be mitigated or avoided by regular and effective quality assurance/quality control procedures for construction and machinery operation. The potential for pollution of aquatic habitats could be reduced or prevented through effective containment and cleanup procedures.

Surface Water Withdrawal (3.3.2.7)

Although the primary water source for the project will be groundwater, there may be certain instances when withdrawal of surface water for construction, dust control, or revegetation may be contemplated. Since surface waters of the desert regions of the southwest U.S. are scarce, the use of this water is invariably already subject to heavy prior use by livestock, agriculture, wildlife, and resident aquatic species.

Withdrawal of water directly from surface waters could be the most damaging of all potential impacts to sensitive aquatic habitats. Where this has occurred previously as a result of agriculture or road construction, extinction of fish species has resulted (e.g., Ash Meadows and Pahranagat valleys). Surface water use not only disturbs the habitat, but also reduces its extent. Any free-swimming or floating aquatic biota are likely to be pumped out of the habitat, depending upon the amount and rate of water withdrawn.

The primary mitigation for this potential impact would be the strict prohibition of water withdrawal from small surface water habitats, especially those that are known to contain sensitive aquatic species. Even a seemingly barren aquatic habitat may contain as yet undescribed species of cryptic fish or invertebrates; this is not to mention the potential critical nature of the habitat to desert wildlife which may depend on its water supply for survival. The next nearest aquatic habitat may be located at a travel distance greater than can be tolerated by resident wildlife. Water requirement impacts to wildlife are discussed in another section of this report.

Impacts to Floodplains and Wetlands (3.3.2.8)

Executive orders 11988 and 11990 and Section 404 of the Clean Water Act will be followed when M-X facilities are likely to impact floodplains and wetlands. This will include avoidance or minimization of impacts to these areas.

4.0 FUTURE TRENDS WITHOUT THE M-X PROJECT

4.1 NEVADA/UTAH

Over the next 20 years, aquatic habitats and their resident biota will probably remain in approximately their present conditions if M-X is not deployed. Population projections for the 13-county study area indicate an increase of approximately 55 percent from 1980 to 1994 with about 95 percent of this increase in the major population centers of Reno, Las Vegas, Salt Lake City, and Provo. Thus, population growth is expected to be small in most of the potential deployment area. Agricultural development is also expected to be limited; however, pressures to increase utilization of aquatic resources for agriculture will increase proportionately with expanding agricultural development. Current management programs for land use should be adequate to protect most aquatic habitats from degradation since the present water allocation system will restrict increased water use. Recreational use of aquatic habitats, including fishing, will increase in remote areas a considerable distance from these expanding population centers. This has been documented for White Pine County, where increased fishing pressure has resulted from use by Las Vegas residents (McLelland, 1980). Cold water fish hatcheries are currently at production capacity, and no warm water fish hatcheries presently exist. Thus, any substantial increase in fishing pressure will result in decreased angler success unless hatchery capacity and stocking rate are increased.

In the immediate vicinity of mining and energy developments, degradation of aquatic habitats could result from water use, sediment runoff, and recreational uses by in-migrating people. Several large projects already are planned for the study area:

White Pine Co., Nev.	White Pine Power Project
	Reopening of Kennecott mine
Nye Co., Nev.	Anaconda molybdenum mine
Clark Co., Nev.	Harry Allen Power Plant
Millard Co., Utah	Intermountain Power Project
Beaver Co., Utah	Alunite mine
	Pine Grove molybdenum mine

These effects would be addressed, and possibly mitigated, through the EIS process required for such projects.

Protection of aquatic resources, both the rare and endangered and other aquatic biota, will benefit from the growing public interest in environmental resources and from the eventual budgetary prospects for federal and state resource protection and management agencies. Environmental pressures resulting from increased industrial, grazing, or agricultural interests may be balanced by appropriate environmental protection. In conclusion, water use, recreation, and fisheries management, particularly in very localized areas, are expected to increase over the next 20 years within the proposed deployment area.

4.2 TEXAS/NEW MEXICO

In the absence of M-X, aquatic habitats in the Texas/New Mexico High Plains will be undergoing study as potential agricultural water resources. Groundwater overdrafts are expected to make economical extraction of water more difficult over time. The expected maximum lifetime of the Ogallala aquifer is 70 years, but irrigated agriculture is already being abandoned in some areas in the southern part of the study area as water becomes increasingly more expensive to obtain. Thus, the major surface water features are likely to receive increased attention for use as supplementary sources.

The study area contains two major types of aquatic habitat: (1) river valleys and associated springs and (2) playa lakes. The first category includes the drainages of the Pecos, Canadian, and Red rivers. Presently, the Pecos River Compact controls water use in Texas (below the study area) and New Mexico, primarily for irrigation, recreation, and livestock watering. Similar compacts govern water use in the Canadian and Red rivers and associated reservoirs. Water use in all three is nearly at capacity. No long-term change in these habitats or their associated biotas is expected in the near future. Projected annual population increases of 1.5 percent would not be expected to put great pressures on the various warmwater gamefish species. If irrigated farmland acreage gradually is transformed to dryland crop or rangeland, one can expect sediment load to decrease, with improved water quality, and perhaps partial restoration of hard-bottom habitat and associated species populations.

The playa lakes are presently under study as a potential water resource. They are shallow wind-deflation basins dependent on sheet runoff for their water supply. Although most are intermittent, some are permanent. Deepening of the smaller lakes keeps water longer, but at the expense of aquatic habitat area for waterfowl, emergent vegetation, amphibians, and associated intermittent lake invertebrate species. As groundwater becomes increasingly expensive, the playa lakes may be a likely replacement source, which will conflict with their use for migrating and overwintering waterfowl. This use conflict will become more apparent as time passes.

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